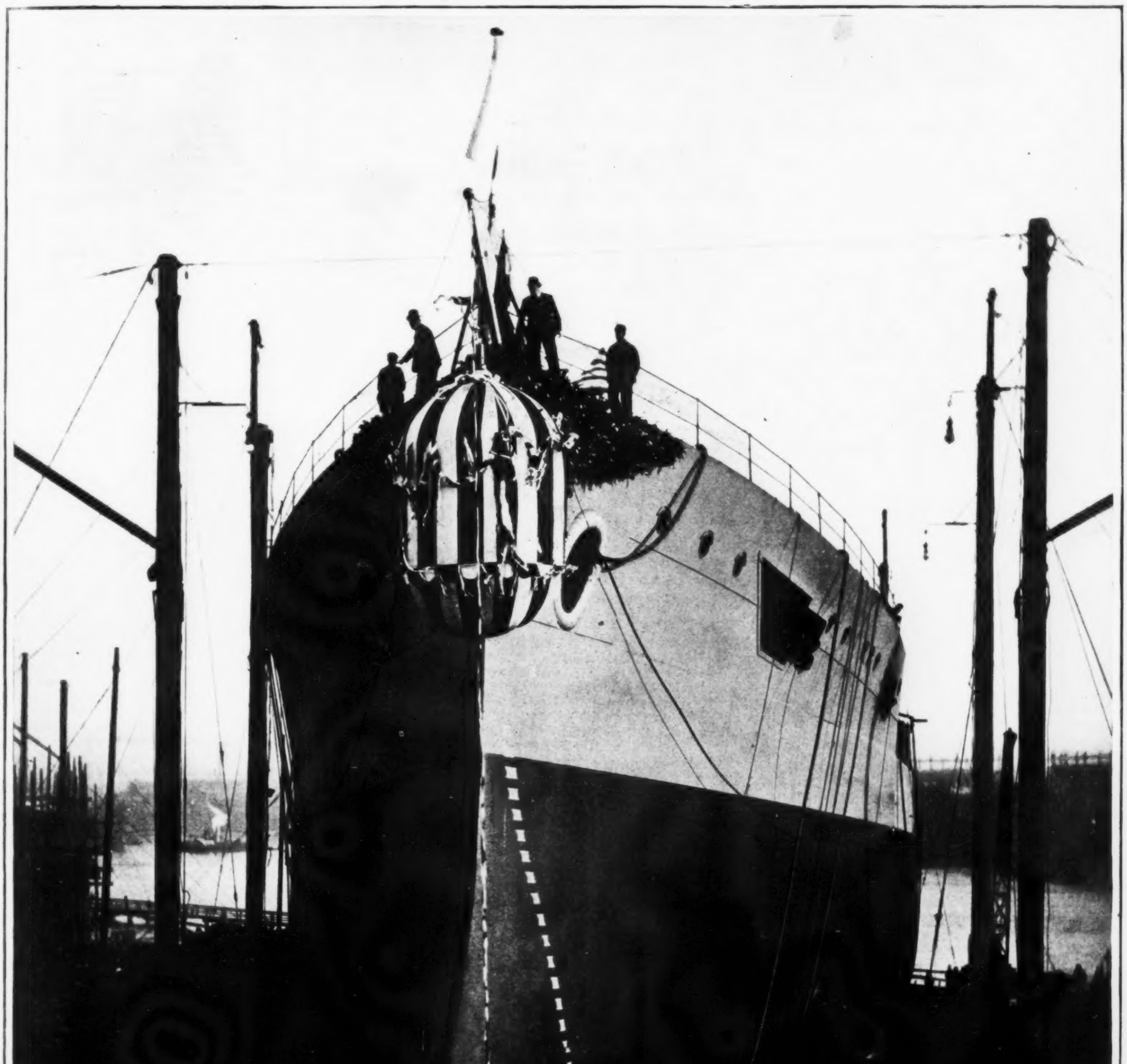
SCIENTIFIC AMERICAN SUPPLEMENT. No 1529

Scientific American, established 1845.
Scientific American Supplement, Vol. LIX., No. 1529.

NEW YORK, APRIL 22, 1905.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



THE JAPANESE BATTLESHIP "KASHIMA" ON THE STOCKS.

THE NEW FIRST-CLASS JAPANESE BATTLESHIP "KASHIMA."*

By Harold J. Shepstone.

The new Japanese battleship "Kashima," which was recently launched from the shipyards of Sir W. G. Armstrong, Whitworth & Co., on the Tyne, England, represents the latest example of the naval shipbuilder's art. It is needless to add that when completed she will be one of the most formidable warships afloat. On the waterline she has a length of 455 feet, breadth 78 feet 2 inches, draft 26 feet 6½ inches, and a displacement of 16,400 tons. The main armament will comprise four 12-inch guns twin mounted in barbettes, four 10-inch guns mounted singly in barbettes, twelve 6-inch guns carried in the citadel, twelve 12-pounder guns, six Maxim guns, three 3-pounder guns, or forty-one heavy guns in all. There are also five torpedo tubes. The 12-inch guns will weigh approximately 59 tons each, and fire a projectile weighing 850 pounds. The charge will be cordite, probably of the modified type. No armor which any ship now carries can hope to cope with their penetrating powers at 3,000 yards.

The armor amidships is carried from below the waterline up to the upper deck. Above this deck additional protection is afforded by a 4-inch screen rising to a height of 7 feet 6 inches above the upper deck, covering the 6-inch gun positions amidships as well as the spaces between the 10-inch gun positions. The main armor belt has a thickness of 9 inches for more than half the vessel's length, and extends the whole length of the ship, tapering slightly at the extremities. This belt extends to 5 feet below water and 2 feet 6 inches above water. Surmounting it is a belt of armor extending in length from the after 12-inch barbettes right forward to the stem. This belt is 6 inches thick amidships and tapered slightly toward the stem. Immediately above this 6-inch belt is the 6-inch citadel armor, reaching to the upper deck, and inclosing the two 12-inch barbettes. Within this citadel are placed ten of the 6-inch guns, separated from each other by screens of 80-pound armor plating; these guns fire through ports similar to those in casemates. The other two 6-inch guns fire through similar ports in the 4-inch screen armor on the upper deck amidships. The barbette armor of the 12-inch guns has a thickness of 9 inches on the upper or exposed portions, and a thickness of 5 inches where protection is afforded by the citadel armor. The thickness of the 10-inch gun barbette armor is 6 inches, that of the conning tower 9 inches, and the observation tower 5 inches. In addition to these protected positions for commanding officers, two more officers' shelters will be provided of 3-inch armor; these will be placed on the boat deck amidships. The steel protective deck running throughout the entire length of the vessel, and covering the whole of the machinery, magazines, etc., has a thickness of 2 inches on the flat portions amidships and 3 inches on the sloping sides. The sides of the deck are carried down, and join the bottom of the main armor belt. At the extremities of the vessel where the armor protection is reduced this deck is 2½ inches thick all over. Further protection is given to the upper structure of the vessel by thick protective plating worked on the top of the screen armor at the level of the boat deck.

The torpedo tubes are located in watertight chambers, two forward and two aft, firing on the broadsides, and one tube firing right astern, also under water. The protection afforded to the engines and boilers of the vessel by the side armor and protective deck is increased by the arrangement of the coal bunkers, which are designed so as to minimize labor in trimming and in getting the coal to the furnaces. In the design of the coal bunkers the chief features aimed at have been (*a*) to secure an arrangement admitting of quick coaling; (*b*) to stow the coal so that it may be easily and expeditiously transferred to the stokeholds; and (*c*) to have a large supply of coal available, so that when going into action all watertight doors may be closed and kept closed during action. The total coal-bunker capacity is, approximately, 2,000 tons, sufficient to insure a large radius of action.

A most complete system of watertight subdivision of the vessel represents another important feature of the design; the inner bottom extends throughout the whole length of the vessel, and is minutely subdivided, while above the inner bottom a considerable number of transverse and longitudinal watertight bulkheads—designed so as to increase the strength and safety of the vessel—are to be found. In connection with the pumping and draining arrangements of the ship there are, in addition to the main pumps in the engine rooms, which can be used if necessary for dealing with a large inrush of water, two 9-inch pumps, two 5½-inch, and one 4½-inch, besides pumps for fresh and salt water services.

In consequence of the immense weight of the vessel, which will exceed 17,000 tons with her full equipment of coal, stores, etc., special arrangements for docking her with safety have been provided, consisting of two docking keels on the flat portions of the bottoms under the bilges amidships, in addition to the usual shoring ribbons for giving support to the armor while in dock. Bilge keels are also provided to reduce rolling in a seaway.

Every provision has been made for efficiently ventilating the numerous compartments of the vessel, and where natural ventilation cannot be obtained, artificial ventilation is provided by means of numerous electrical fans, with air trunks, branches, pipes, etc. A refrigerating engine for preserving provisions, etc., is provided, and this engine is arranged in conjunction with an installation of thermo tanks, to regulate the supply of cold air to the magazines. The electric lighting installation will include six searchlights and some 1,250 incandescent lamps. The vessel will be fitted with two large steel masts, each carrying two tops for the reception of searchlights and the control of gun-fire apparatus. The anchor and cable outfit includes three stockless bower anchors, each of 120 hundredweight, and three main cables of 2⅝-inch stud chain, each of 150 fathoms; there are other smaller anchors and cables. Accommodation will be provided for a complement of 980 officers and crew.

There will be twenty boilers arranged in three separate rooms; these will have a working pressure of 230 pounds, a grate surface of 1,300 square feet, and a heating surface of 43,000 square feet. The twin engines will have four cylinders each, 36 inches, 56 inches, 63 inches, and 63 inches, with a stroke of 48 inches. The horse-power of the engines will be sufficient to give the vessel a speed of 18½ knots. With the exception of the main propelling machinery and boilers, the whole of the ship, including armor, armament, fittings, etc., will be supplied by Sir W. G. Armstrong, Whitworth & Co. It is interesting to note that the first keel plate of the "Kashima" was laid on February 29, 1904, but it was not until a month after that date that uninterrupted progress began with the work of actual construction, so that an exceedingly rapid rate of progress of construction has thus far been maintained.

* Specially prepared for the Scientific American Supplement.

CEMENT POSTS.*

By C. L. Catherman.

A demand exists for posts that are strong, convenient and durable. They must also be inexpensive. In the greater part of our country, timber suitable for posts is fast disappearing. The quality of the wood posts is becoming inferior and the prices are advancing. The life of an ordinary white cedar post, which is the most common in use, varies from five to nine years. It is safe to say that in forty years at least five sets of new posts are required. Although prices of cedar posts vary in different localities, yet we may safely say that an average of 16 cents apiece is a reasonable price. The posts would cost at this rate five times 16 or 80 cents. The labor involved in resetting posts and fastening fences during this time will amount to no less than 20 cents, making the total cost no less than $1. Many have tried iron and steel posts, but the constant action of the atmospheric agencies, especially at the soil line, soon works destruction to the posts unless they are of large size, which increases the cost too much.

In view of the fact that wood is becoming scarce and high in price and that it soon rots, and that iron and steel are also unsatisfactory, substitutes have been tried, but it was not until Portland cement began to be used extensively that a practicable substitute was found at a reasonable cost.

I think it unnecessary at this time to say much about the strength of concrete, its fire-resisting qualities, its increasing hardness and strength as it increases with age, and its resistance to the disintegrating effects of frost. I am aware that the men of this convention are so familiar with facts concerning concrete work that the mere statement is accepted without any doubts that a cement post well made and of good material is sufficiently strong when properly reinforced that it cannot break under any ordinary conditions, that fire will not injure it, that it will increase in hardness with age, and that frost will not injure it.

There are, however, several important phases of the cement post question which should be considered.

Experience and observation have sufficiently demonstrated the necessity of a reinforcing device. Good materials and carefully prepared are essential, but the vital factor of the cement post is its proper reinforcing.

The earlier form of cement post consisted of a wood post embedded in a concrete base, but this proved unsatisfactory for two reasons: It did not prevent the post from rotting, gave it no more strength, and with the expansion and contraction of the wood, due to different degrees of moisture, either caused the concrete to crack or the wood core to become loose in the base. This led to a later form, in which wood was completely embedded in the concrete, and was intended to serve as a reinforcing device and as a preservation of the wood, but this plan failed for two reasons. There is but little bond between wood and concrete, and therefore the wood fails in a purpose to reinforce, and the swelling of the wood cracks the concrete, or it shrinks in the post and becomes loose.

A step in advance was made when metallic reinforcements were used. Several different forms of metallic reinforcements have been used and patented, but there are a few precautions to use even with the metallic reinforcements. It is better to use the metal distributed in the corners than to use the same amount in a solid rod through the center. The reinforcing devices should have rough surfaces or means to prevent their slipping when the post is under strain. Barbed wire is an ideal reinforcement.

The ratio of cement and sand depends on the quality of the material, varying from one to three to one to five. Good, sharp, clean sand and gravel should be used. Gravel passing through a half-inch mesh is satisfactory, but enough fine material should be used to fill all voids. I prefer sand and gravel to crushed rock, although I have had but little experience with the crushed rock. A neater post can be made by using the "dry" mix, but it requires more care and time than the "wet" mix. I use the "wet" mix almost entirely and prefer it, for the staples can be more easily embedded and the tamping can be done quickly and easily and without interfering with the reinforcing wires. And let me add right here that wood molds are proving the best "post machine" that has yet been offered for the manufacture of cement posts. I use the wood molds in sets of five resting on one pallet of wood or cement covered with a coating of shellac. I refer to the molds for the line posts. Posts of special design can perhaps better be made in single molds. One advantage especially of the wood molds is their low cost. A man can equip an extensive plant with but little capital. The molds can be used for a number of years if proper care of them is taken. It is a good thing to give the molds a coating of shellac. In using the "dry" mix it would be better to make the posts in a single mold, for the mold is removed as soon as the post is made. Using the "wet" mix, posts should remain in molds at least twenty-four hours.

Right here has been the chief cause for failures which some men have had in trying to manufacture cement posts. It must be understood by all that a post cannot be made like a block. The block can be made by a machine, rest on a pallet, and be carried off. The post cannot, or should not, be carried away on a pallet immediately after it is made. The post is long and heavy and its weight will cause the pallet to sag in the middle and if carried when green the post will surely crack. The cracks may not be visible at the time, but they will be in evidence when the post is cured.

Quite a number of failures have resulted in experimenting with cement posts. There are several reasons: In some instances not enough cement was used. It is false economy to try to rob the post of cement. I am of the opinion that no less than a one to five ratio of cement should be used, although a strong post can be made from a less proportion, but such a post should not be used or submitted to strain less than a year after it is made.

Another reason for failures is that posts have been used too soon after they were made. It is a well-known fact that concrete does not attain its maximum strength for several years.

There are instances where posts were used ten days after they were made. They will stand as line posts provided they receive no jar, but a post should be thoroughly cured before used and this will take at least a month. Six months is better and a year's curing will yield a post practically unbreakable.

It is my opinion that where the post was properly made no less than seventy-five per cent of the failures have resulted because they were moved before the posts had set and cured. Posts must not be moved from their pallet until they have set and hardened. Until I had considerable experience in making posts I found a number of them cracked when I wanted to use them. The reinforcing with wires of course prevented the posts from bending over or breaking off, but I could not for some time ascertain why the posts were cracked. But I soon discovered the cause. It was due to the fact that I had moved the post before it had cured, and that moving it, although I was ever so careful, had caused small hair cracks to be made which at that time were invisible, yet were there in fact and were sure to show later. If a post machine ever proves a success it must be built in such a way that the machine shall be moved away from the post rather than the post shall be moved from the machine.

But the manufacture of cement posts is no longer an experiment. When properly made, properly reinforced and well cured before being handled they are very satisfactory. I know of cement posts in use in a fence for about twelve years, and the posts to-day are in as good condition as when first put in the ground. I know of cement anchor posts used for a windmill that have been in use for eighteen years, and another instance for twenty years, and they are in perfect condition to-day.

One problem to solve was how to fasten a fence to a cement post. One of the first methods was to wrap wire around the post. This answers the purpose, but requires considerable time to fasten the fence and is not neat in appearance. Another device was to put holes through the post. There are a few objections to make to this plan. It is not adapted to a woven wire fence nor to a barbed wire fence. It also requires considerable time to make the holes and also weakens the post. Cleats of wood embedded in the post to which the fence might be nailed have proved unsatisfactory on account of the swelling and drying out of the wood. A better plan is to bolt cleats of wood to the post and nail to them. The devices that have given the best satisfaction are suitable staples which can be embedded in the post where desired, and a lock or retaining rod inserted through the staples holding the fence wires between this retaining rod and the post. The special feature of this device is its convenience. A fence can quickly be attached and any time it is desired to remove the fence from the posts, the rods can quickly be pulled out, loosening the fence from the posts. One advantage of a cement post, besides its indestructibility, is its neat and tidy appearance. It is also especially adapted for ornamental purposes, since it can be molded into any form or size. Besides fence posts they can be used as mile, hitching,

* A paper before the convention of Iowa Cement Users.

mail box, telephone, park, dooryard, cemetery, and especially vineyard posts.

An additional feature of most of the cement posts now manufactured is a device for protection against lightning. This is a very practicable and beneficial device and should be used on posts in wire fences.

The superiority of cement posts over wood, iron or steel posts is their indestructibility and consequent saving of cost. It is a matter of economy to use a cement post. I stated before that to maintain a wood post for forty years, including cost of labor to set it, is no less than $1.00. How much will a cement post cost for the same period of time? A line post 7 feet long should contain approximately the following amount of materials:

From 12½ to 16 pounds of Portland cement, at least 2 pounds of metallic reinforcement and a little over ½ cubic foot of sand and gravel. Cement at $1.50 will cost from 5 to 6 cents. Wire at 2¾ cents, 5½ cents. Sand and gravel at 50 cents per cubic yard, a very little over 1 cent. You may estimate 12½ cents to 13 cents for material. Two men can make 100 posts per day, hence the cost for labor will be from 3 cents to 4 cents, making the post cost complete from 15 cents to 17 cents. They can be made and sold at a reasonable profit for 25 cents, but they are cheaper to buy at 30 cents than wood posts at the prevailing prices. The cement post will last longer than forty years, during which time it costs to maintain a wood post at least $1.00.

Cement posts can be made on the farm. The farmer can make them for himself at a very low cost, for he can make them at times when farm work is not urging. He can in this way have his men employed to good advantage and have the posts ready for use when he needs them. It is a good way to keep the boys on the farm to let them make posts to sell. They are interested in such matters and are pleased to have a plant of their own and engage in a profitable business.

In many localities the heaving of posts by frost is a perplexing difficulty. I make my posts gradually tapering from the top to the base. This feature, combined with the weight, prevents in a large measure the heaving, the posts being securely anchored on account of their shape.

Another advantage is that there are no disadvantages. Every feature of a cement post can be placed on the credit side. Briefly, a cement post costs no more than a good wood post; is indestructible, is adapted for all kinds of purposes; is strong; is a money saver; is a post that when attached to a good fence will keep stock in or out of a field; is fireproof and especially adapted for railroads; is neat and tidy; is not affected by heat, cold, moisture, frost or rain; is a sure means of increasing value to the property where used; is the post for concrete workers to manufacture and secure good profits because it is a ready seller; is the post for the future as well as the present.

PATINA AND ITS CHEMISTRY.

By DR. OTTO N. WITT.

THE rusting of iron is typical of the patination of metallic objects of art. Art connoisseurs, indeed, regard rust as the very opposite of true patina, for the latter embellishes, while rust destroys; but to the chemist who seeks a clear understanding of the process before judging its effects, rusting and the formation of patina in the narrower sense of the word are closely related.

Common to both is the necessity for the presence of some substance in addition to those which analysis proves to be the raw material and the final product. Iron rust is easily shown to be simply ferric hydroxide, a compound of iron, oxygen, and water. Iron existed in the rusting object, oxygen and water are known constituents of the atmosphere. What, then, is more natural than the assumption that these three substances, which evidently are endowed with mutual affinity, have spontaneously united to form rust?

But when we consider that air which contains water vapor bathes every bit of iron on earth we must wonder why some iron objects rust easily and others very little or not at all. Who ever saw rust on a razor in actual service, which is not only exposed unprotected to the air but is moistened every time it is used? The varying behavior of iron objects cannot depend—entirely, at least—upon the composition of the metal, for we often see the same objects rust under certain conditions, but not under others apparently identical. Consider a bunch of keys carried in the pocket. In each bunch various sorts of iron occur, yet all of some person's keys remain bright while those of others are always rusty, despite continual scouring due to carrying in the pocket. But men who usually keep their keys bright fail to do so under certain conditions, as on a long sea voyage. Then their keys rust like those of other mortals, but when they return to normal conditions the rust disappears as mysteriously as it came.

But I will stop proposing riddles and proceed to crack the nuts laid before my readers. Everything becomes clear when we examine the rusting process more closely.

Then it becomes apparent that iron, oxygen, and water do not suffice to produce rust. The purely metallic surface of iron or steel (which is the same for our purpose) remains bright in dry air, and in *pure* moist air, but rusts promptly in moist air containing any trace of acid, or if the metal is moistened, even for an instant, with the weakest acid. A knife which has long remained bright begins to rust, irrevocably and irresistibly, as soon as an apple is peeled with it, although it is thoroughly wiped or even washed immediately after the operation. Only scouring with emery or other powder or grinding on a stone, that is to say, only the formation of a new metallic surface, will restore its property of remaining bright.

How do such immeasurably small quantities of acid produce progressive and unlimited effects? This question now admits of exact answer.

Iron is easily attacked and dissolved by the weakest acids, with evolution of hydrogen and formation of a ferrous salt. This process ceases as soon as all the acid has been consumed. Ferrous salts, however, are not permanent in the air. They absorb oxygen and are converted into basic ferric salts which, in turn, very easily decompose, separating ferric hydroxide or iron rust. The other product of decomposition is the normal ferric salt which, again, is attacked by the metallic iron and reconverted into ferrous salt. This circle of operations may be repeated indefinitely. As soon as a trace of iron salt is formed the action commences and continues, constructing from the iron and the air a coat of rust which grows as the metal under it diminishes. Thus heavy objects like swords, lance-heads, armor, door-hinges and locks are, in the course of centuries, literally eaten up and destroyed.

We see, too, why razors and many other things show not the slightest tendency to rust. Not only is a razor never brought into contact with acids, but whenever it is used it is moistened with soap suds which, being alkaline, neutralize any chance trace of acid and prevent its catalytic action. Keys carried by many persons remain bright for a similar reason. Such persons exude—because of the immaculate purity of their souls, perhaps—slightly ammoniacal perspiration which neutralizes and makes harmless any trace of acid that may cling to their keys. On the other hand the keys of persons whose perspiration is acid are peculiarly liable to rust because the acid rubbed off the keys by continual attrition is continually replaced.

From the foregoing it is evident why a knife once used to peel an apple shows an incurable propensity to go on rusting. But apples are not the only source of the acid unconditionally requisite for the inception of the rusting process. Sometimes the carbonic acid always present in the air suffices, though it seldom attacks metallic iron. Far more dangerous is the sulphuric acid produced in the combustion of coal. This does not exist in the air as vapor but is carried in infinitesimal quantities by suspended dust and soot. Hence both, but soot especially, are very effective promoters of rust. A polished steel plate left undisturbed in the air becomes dusty and soon begins to rust. If it is examined with a strong lens at this stage, before rusting has progressed too far, the rust is seen to begin and expand from individual dust particles, usually consisting of soot.

Everyone knows that iron rusts must faster aboard ship and at the seacoast than in inland districts. This is usually attributed to salt reduced to dust by the breakers, but this explanation is not quite correct. If the experiment with the steel plate is modified by dusting the metal with pure rock salt obtained by pulverizing a clear crystal, increase of rust due to the salt is hardly perceptible. In fact, the rusting effect of sea spray is due not to its common salt, but to its much smaller proportion of magnesium chloride. In this salt chlorine is held much more loosely than in sodium chloride and under certain conditions it may separate in the form of hydrochloric acid which surpasses most other acids, including sulphuric, in power to initiate rusting. The same holds true of hydrobromic acid which occurs in sea water in the form of magnesium bromide.

Ocean spray is carried inland by the wind to astonishing distances. It is the chief source of the chlorine of our fresh-water streams and undoubtedly contributes to the rusting of iron. The air of high mountain regions contains neither ocean spray nor soot, and there, consequently, the plague of rust is notably diminished.

On the other hand it is scarcely necessary to point out the important part played in the formation of rust by the mechanical transformation of surface previously described. Dust and soot are easily wiped away from polished iron and steel and thus the first incentive to rusting is removed. Now, as iron, and especially steel, are hard enough to withstand mechanical injuries to their polish for a long period, bright steel and iron ware may long be kept free from rust by mere wiping and occasional washing and thorough drying. But when the surface has become at all rough, so that the dust cannot be completely removed, rusting soon begins unless the rust-producing influences are combated by frequent renewal of the metallic surface, as in knife cleaning.

Mutatis mutandis, what has been said of rust applies also to the beautiful gray, green, or blue-green coating on copper and bronze roofs and art objects that is known and prized as patina. Here, however, the conditions are far more complex than in rusting, so that, with a great range of possibilities, it is sometimes almost impossible to form a clear conception of the process that has taken place in a given case.

Corresponding to the greater resistance offered to chemical action by copper and its alloys, in comparison with iron, patina is formed far more slowly than iron rust and years are needed to produce visible results. This fact alone greatly increases the difficulty of observing and analyzing the process, but the main difficulty lies in the extremely variable composition of the materials which, though all alloys of copper, behave very differently in respect to patination—so much so that a very slight difference in composition may lead to a total change in the patina.

For many years I have had in my care a number of medals cast in the same mold but of different sorts of bronze. They are slowly acquiring patina and already present a very variegated appearance. Some are blackened, others gray, still others greenish. The difference in the behavior of bronzes of slightly varied composition is shown still more strikingly by the groups recently placed in the Berlin Thiergarten. Most of them still have the metallic color of newly "bitten" bronze castings, although the golden luster is distinctly dimmed, but the reclining stags at the entrance to the Hofjaegerallee already show plainly the greenish shimmer of incipient patination. Yet the difference in composition cannot be great, for well-marked differences in tint would not occur in bronze of related groups.

Whatever may be the composition of the metal, a compound of copper is always the essential part of the patina itself. This alone has the peculiar blue-green tint which gives to true patina its artistic charm. The simplest case of patination may be observed, therefore, on the unalloyed copper of many old and a few recent palace and church roofs. Statues, also, are occasionally made of copper, a celebrated example being the colossal figure of Saint Charles Borromeo at Arona on Lago (the lake of Como) Maggiore. But much old copper is very impure and no observations have been made of the patination of really pure copper, such as is now produced by electrolysis.

The chemical process of the patination of copper is related, but not precisely analogous to the formation of iron rust. Here also we have to do with the catalytic effect of minute quantities of acid, but the action is less persistent and the formation of patina soon ceases unless it is maintained by fresh accessions of acid.

With copper, too, the nature of the acid is not a matter of indifference as it probably is with iron. On copper sulphuric acid acts very differently from hydrochloric acid or salts which evolve it, such as magnesium chloride. In both cases the first effect is the production of the normal cupric salt; but, while cupric sulphate is little affected by contact with metallic copper, cupric chloride is decomposed as ferric salts are in the rusting process. The result is cupric chloride, a salt of the suboxide of copper, which is then oxidized by the air to basic cupric chloride. The latter shows little tendency to separate into cupric hydroxide and normal salt, which could again be reduced to cuprous chloride, but remains, for the most part, in the basic form. Copper patina, therefore, is not a hydroxide like iron rust. Now, as much of the acid is held in combination in the basic chloride the necessity of fresh supplies of acid to the continuance of the process is evident.

As has been mentioned, cupric sulphate has but slight affinity for metallic copper, and it also shows little tendency to assume the basic form. Hence it is usually washed away by rain as fast as it is formed. For this reason no true patina is formed on bronze in inland regions where atmospheric acidity is due chiefly to sulphuric acid, while near the seacoast, where the salt, or rather the chloride, suspended in the air evolves hydrochloric acid either spontaneously or under the influence of the sulphuric acid of smoke, patina develops steadily. This statement will be confirmed by a glance at the bronze statues and copper roofs of Hamburg, Bremen, Copenhagen, Stockholm, Christiania, and St. Petersburg.

In this difference between the effects of sulphuric and hydrochloric acids lies one of the great secrets of patina, which strangely seems to have quite escaped earlier observers. This knowledge enables us to appreciate as they deserve certain foolish assertions which continually reappear.

I refer to the oft-repeated fable, told of both bronzes and paintings, that the artists of old knowingly used certain formulas designed to lead inevitably to the results which actually appeared later, and that they carried these secrets to their graves. Nothing can be more foolish than such assertions, which not only are entirely unfounded, but lead into wrong channels the endeavors of those who are seeking something better than our present knowledge.

The truth is that the bronzes of Greece, Rome, and Egypt became covered with patina because those countries lay on the sea coast exposed to ocean breezes. These bronzes thus acquired the chloride patina which forms to-day on the bronzes and copper roofs of Hamburg and Copenhagen.

"This explanation is not correct," I hear the disseminator of the nursery tale of lost secrets retort, "for the older bronzes of inland places, the statue of the Great Elector on the Schloss bridge in Berlin, for example, readily acquired patina, but the newer bronzes do not."

The answer is very simple and the Great Elector is my best witness. In olden times the fuel of Berlin and other inland places was wood, and wood smoke contains no sulphuric acid worth speaking of. The only acids to which bronzes were exposed were the traces of hydrochloric acid, and chlorides evolving it, brought from the coast by violent winds. The result was a patina like that of the coast, but of slower growth. But since we have been burning coal and thus throwing into the air thousands of tons* of sulphuric acid this typical patination has ceased and has been replaced by the mechanical process of dust patination previously

* The city of Hanover annually pours forth, in smoke, 4,500 metric tons of sulphuric acid, from which statement the immense quantities produced by Berlin and London may be roughly estimated.

described. The effect of the sulphuric acid upon the copper is merely to roughen the surface and prepare it for patination by dust.

It is said that the Great Elector was formerly covered with a remarkably beautiful patina which was scraped off by a foolish commission, and that the noble bronze took umbrage and refused to renew the process.

It is of no consequence whether this crime was committed or not, but if the statue formerly acquired patina and now refuses to do so, this proves clearly, not that it is made of bronze of secret composition which cannot now be reproduced, but that, though the bronze remains the same, atmospheric conditions in Berlin have changed and are no longer favorable to the formation of true patina.

Quod erat demonstrandum.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

FRICTION CLUTCHES.*

By GEORGE A. F. POVER.

EVERY engineer is familiar with friction clutches in one form or another; in fact, the ordinary cone clutch is a very old invention; it is only, however, during the last few years that engineers and others have seriously attacked the problem of designing an efficient clutch. A search through the Patent Office records would show that there are numerous clutches patented, each of which (according to the patentee) is perfect and meets every requirement; but is this so? Let us look into the question as to what constitutes a perfect clutch. Mr. Walter Bagshaw, before the Institution of Civil Engineers (session 1886-7), stated the following to be the essential requirements of a clutch:

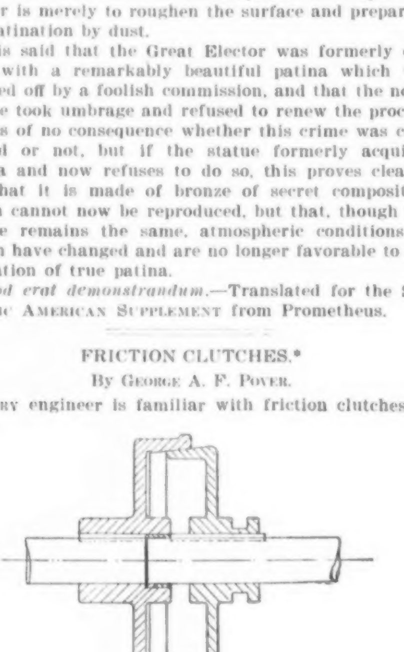


FIG. 1.—ORDINARY CONE CLUTCH.

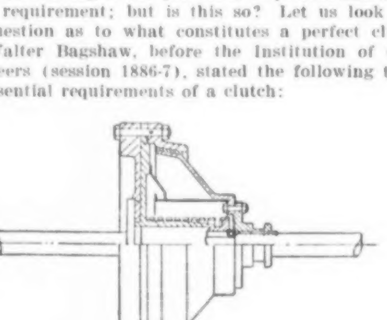


FIG. 2.—LEATHER-COVERED CONE CLUTCH, FOR MOTOR CARS.

1. Positive reliance at all speeds and under severe and sudden strains.
2. Ease in throwing in and out of gear while in motion.
3. Freedom from shocks.
4. Non-liability to wear or derangement.
5. No tendency to work out of gear.
6. Last, but not least, moderate price.

Prof. Hele-Shaw, in a paper read before the Institute of Mechanical Engineers in 1903, gives the following four conditions as being involved in the problem:

1. The clutch must have sufficient gripping power.
2. Undue wearing of the surfaces must be avoided.
3. Provision must be made for conveying away the heat, when there is much slipping of the clutch.

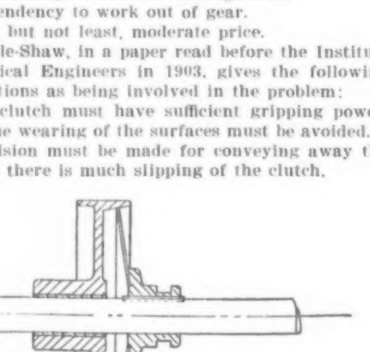


FIG. 3.—DISK CLUTCH, FOR LIGHT POWERS.

4. Motion should be imparted to the driven shaft without shock.

Thus we see that, at the outset, we have to meet conditions which, according to mechanical science, we are unable to reconcile.

Speaking for myself, having had considerable experience in this matter, I do not believe there is a single clutch at present made which would meet all the above requirements under every condition it is possible to name. At the same time, I believe it would be possible to pick out a clutch from the number subsequently described, suitable to meet as nearly as possible the above requirements, provided that we know exactly under what conditions the clutch has to work. Let me give an example or two to show what I mean. Suppose we have a high-speed motor always running in one direction, developing a large horse-power, and we wish to fit a clutch so that the work may be stopped, enabling us to keep the motor always running: is it reasonable

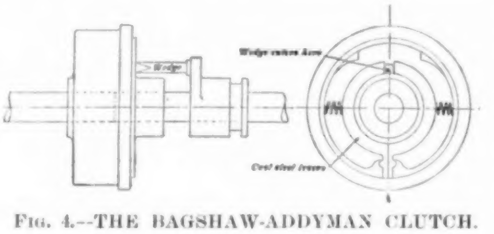


FIG. 4.—THE BAGSHAW-ADDYMAN CLUTCH.

to expect the type of clutch suitable in this case to work equally well when used to drive (say) a heavy rolling mill which is doing very excessive work, but at a low speed? Or should we fit an elaborate and expensive clutch to a pulley on the line shaft in an amateur's workshop, to do possibly less than 1 horse-power?

I shall now describe a number of characteristic clutches, and give their advantages and disadvantages, and state under what conditions one type is preferable to another.

Take first the ordinary cone-clutch (Fig. 1). We here have the simplest form of clutch it is possible to make; one portion is keyed to the driving shaft, and the male portion slides on feathers on the driven shaft, the end of the driven shaft being carried in bush, which is secured to the driving portion of clutch. The advantages to be derived from its adoption are: Low price, simplicity of construction, and small movement

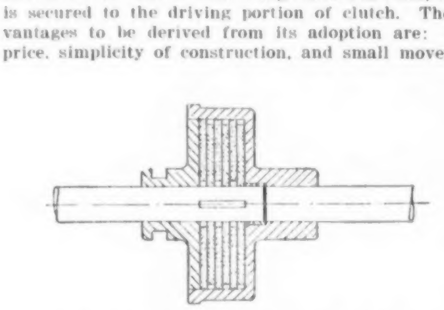


FIG. 5.—THE WESTON CLUTCH.

required to put in gear. The disadvantages are: Destruction of surface if allowed to slip much, constant end thrust on shaft, and liability to work out of gear.

In Fig. 2, we have one of the many modifications of the cone clutch. This is a clutch much used in one form or another on modern motor cars. It will be noticed that a band of leather is secured to the outside of the male portion of the clutch, while on the inside will be seen a guard fitted to prevent oil from the engine or gear-box reaching the leather. With proper attention and careful usage, this clutch is fairly satisfactory, but is liable to be put out of use by oil getting on the leather, and by burning out—by no means a rare occurrence. Fig. 3 shows a type of clutch very suitable for light work. As shown, a disk of metal is cambered and attached to the sliding portion of the clutch which, on being pressed into the pulley, engages with this. It is only suitable for the very lightest of work, as the friction surface is so small.

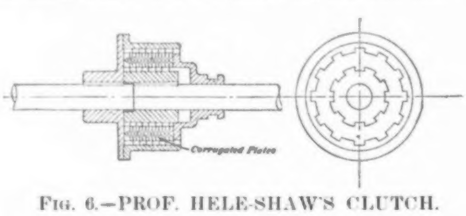


FIG. 6.—PROF. HELE-SHAW'S CLUTCH.

In Fig. 4 we have one of the many forms of drum expanding clutch, in which a ring or segments are forced into contact by wedges, right- and left-handed screws, toggle joints, etc. These clutches work well when doing light work if they are not required to slip much. If much slipping occurs, undue wear and much heating take place, which make frequent adjustment necessary, and in time destroy the surface. In Fig. 5 is shown the Weston clutch, in which the friction effect is produced by a number of circular disks, connected alternately with the driving and driven ends of shaft. With this clutch we might include the brush clutch, in which brushes of wire are thrust into a grooved plate.

In my opinion, Fig. 6 shows a vastly improved form of this clutch, due to Prof. Hele-Shaw. It will be seen that the plates and brushes of the preceding clutches have been replaced by corrugated disks of thin sheet metal alternately serrated on the outside and inside, to fit into grooves cast in the driving and driven portion of clutch. These clutches are made in various forms; some are air-cooled and others are inclosed, and run in oil. From experiments made, it would appear that where there is much slipping, and for high speeds, we have in this an ideal clutch. Whether the plates are liable to rapid wear is a point we cannot now decide, as the clutches are so little known and have not had the test of time.

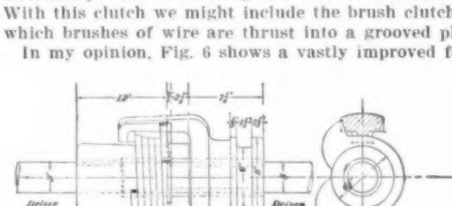


FIG. 7.—COIL CLUTCH (CLASS F).

We now come to an altogether different type of clutch, in which the well-known gripping power of a coil of steel or rope is made use of.

In Fig. 7 we have the simplest form of this clutch, in which a coil of steel with lugs at each end engages with a casting which slides on feathers and forces the coil on the cone, and thus causes it to wind up and grip. This clutch can be used to drive very heavy machinery; it has now been in use for a number of years, and for its particular duty is found to be entirely satisfactory. This clutch drives in both directions, a point in which it differs from other clutches of the same principle, which I have to describe. The only apparent

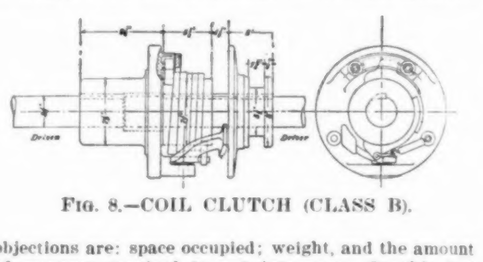


FIG. 8.—COIL CLUTCH (CLASS B).

objections are: space occupied; weight, and the amount of pressure required to put into gear. On this last point it must be remembered, that once the clutch is in gear, there is no end thrust whatever on the shaft.

In Fig. 8 is shown a type of clutch much in vogue for heavy work at speeds up to 150 revolutions per minute. The coil is still used, but it is fitted on a parallel drum, and is wrapped up by means of the bell-crank lever, this lever being pressed into position by means of the sliding disk shown. With this clutch there is always a certain amount of end pressure on the shaft, but at the speeds given this has not been found detrimental. When I mention that this type of clutch is used for reversing rolling mills (which are reversed, say, every thirty seconds), with drums 36 inches diameter, and 19-inch shaft, with an area at coil head of 36 square inches, it will be seen that these clutches are capable of work which seems incredible to people unacquainted with their capabilities.

The clutch shown in Fig. 9 has been designed to overcome the objections sometimes raised, of end pressure and unprotectedness of clutch. It will be seen that the

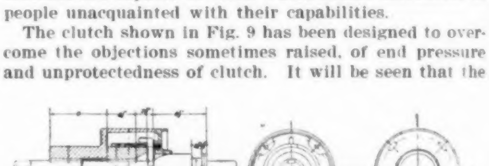


FIG. 9.—COIL CLUTCH (CLASS D).

principle is exactly the same, but the method employed for wrapping up the coil is different. In this case a vertical lever is attached to the cover plate of the clutch. This cover plate is slotted, as shown, so that any necessary adjustment may be easily made. The sliding portion engaging the lever is made spherical, so that when the clutch is in gear there is absolutely no end pressure on the shaft. As the clutch is entirely cased in and filled with oil, it is possible to work it with very little attention when once adjusted. This clutch picks up its load very smoothly, and is largely used for fitting to the pulleys of electric motors, when the work has to be stopped without stopping the motor.

We now come to the last clutch shown (Fig. 10), which I think is a radical departure from anything

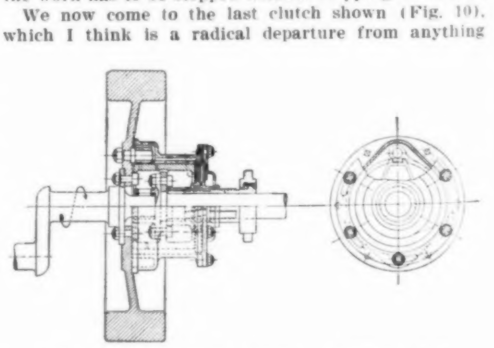


FIG. 10.—IMPROVED COIL CLUTCH, FOR MOTOR CARS.

that has yet been made in the way of clutches. It is specially designed for motor-car work, and in practice works to the entire satisfaction of everyone. It will be seen, although the coil is still in use, that there are many features which are new. The chilled drum is made hollow, and in this drum are holes through which oil is drawn by centrifugal action right to the part where it is required. This is a point which, I think, will overcome much of the trouble caused by heating. A lubricator is fitted to the cover, so that it is possible to feed the hollow drum with oil, although the motor may be running at 1,000 revolutions per minute. The method of wrapping up the coil is clearly shown, and

* Technics.

is entirely under the control of the driver. The weight has been cut down to a minimum, and when I say that the clutch shown only weighs one pound for every horse power transmitted, it will be admitted that we have a clutch which should be in great demand by makers of all types of cars.

In conclusion I must acknowledge my indebtedness to Prof. Hele-Shaw for much information, taken from his paper concerning his type of clutch, and also to the Consolidated Engineering Company for the information that has been given me concerning coil-clutches.

THE MOTOR SPRING AND ITS CALCULATION.

THE so-called main-spring finds manifold application as the cheapest and simplest means of mechanical power for small machines and apparatus. Known formerly only in the watch and clock industry, it has now become an important adjunct in the most varied branches and finds a field not only in watches but in music boxes, phonographs, measuring apparatus, telegraphic recorders, ventilators, rotary fans, mechanical toys, automatic window shades and a myriad of other articles. Technicians and inventors are ceaselessly striving for other openings which may be filled by the driving power of the coiled spring, such as motor cycles, autos, sewing machines, or other mechanical appliances used in the domestic economy, but for the most part with feeble results.

Innumerable costly attempts have been wrecked because of the complete misunderstanding of the character of the motor spring.

Every man who considers himself an expert in this branch of mechanics could write a chapter upon the subject: upon the peculiar demands that are made upon the main-spring and how rarely, outside of the watch and clock-making industry, this spring is properly applied. The object of this article shall be to set forth the essential and ruling features in the application of the spring.

First, we shall consider its driving-power. It is by no means rare, in fact it is of weekly occurrence that the spring manufacturers are called upon to answer questions of this sort: "What will be the cost of a driving spring that will deliver ¼ horse-power during three hours upon 100 turns?"

This is only a sample question but the import is alike in all. Here then it is plain that the power delivered by the spring is looked upon as a constant quantity, which is a fundamental error. A spring completely wound up exerts its greatest power during the first few turns, delivering considerably less power at each subsequent turn as it runs down; even very strong and long springs afford a profitable service of at most 18 revolutions. From this point on, the friction of the layers of the steel band against their neighbors consumes the remainder of the energy. In order to obtain a running period of three hours, it would be necessary to supply a corresponding train and a governor, and the friction of these added parts would be almost sufficient to absorb the whole power remaining in the spring, supposing even that the running work be as exactly constructed and as carefully put together as that of a watch; indeed, then the surplus power over and above that required to drive a gear up to 1,200 would be very small indeed.

Furthermore, the motive force of such a spring is very often calculated upon the cubic contents of the cross-section of the steel band or perhaps it might more properly be said to be estimated from such a cross section. We may declare this also to be an error, even though it may have all the appearance of theoretical correctness upon its side, particularly when it is based upon technical formulas; in other words, when the coefficient of pliability is taken into consideration.

Not infrequently we run up against another no less faulty opinion, that the spring, if given double the cross section, will exert twice the motive force, and this is stated without regard to the direction in which the cross section is to be increased. Bear in mind that the motive force of a hardened steel spring depends not only upon the superior quality of the material of which it is made, its thickness, and its width, but also essentially upon its length, upon the diameter of the core or arbor upon which it is wound, upon the ratio between its length and the diameter of the barrel inclosing it, and more or less upon the smoothness of finish of the exterior surfaces of the spring itself; for the friction of one turn of the spring upon its neighbors on either side is a factor by no means to be neglected. It is accordingly always better to try out a motor spring.

We give below several important rules to be carefully noted by the practical man in his application of the motor-spring. Inside the barrel, under normal conditions, the diameter of the winding arbor should cover about one-third of the diameter of the barrel. When completely wound up, the layers of the spring should fill out about one-third more of the space. The last one-third should be left empty for the expansion of the spring when running down.

Should the barrel have, for example, a diameter of 60 millimeters, then the arbor should measure 20 millimeters in diameter, and the unwound layers of the spring lying against the outer wall of the barrel should also measure 20 millimeters in thickness or 10 millimeters at each extremity of the diameter.

In cases where new springs are to be made, it were far better to inform the manufacturer concisely concerning the uses to which the completed mechanism is to be put, and leave the calculations to him; if for any cause this proceeding is not desirable, then select a suitable gear work and have a spring of corresponding dimensions made. In such an instance an abundant length must be given the spring so that it will certainly unwind at the very least enough turns to accomplish the work. The spring may be tried out by a provisional barrel or a wire ring.

The spring may then be correspondingly shortened, the diameter of the barrel decreased, or the arbor may be treated in the same way, until the most favorable ratio is reached, thus lopping off all useless weight, and rendering the completed motor less costly to manufacture. During these trials it will be demonstrated that the spring pulls more forcefully the shorter it is, and the smaller the diameter of the arbor about which it is wound. Such a showing will very naturally lead up to the mistake of reducing the arbor to the smallest possible diameter, which in the end may cause the inherent elasticity of the hard steel band to be exceeded, when rupture will most surely follow. The diameter of the arbor must measure from 20 to 25 times the thickness of the spring itself.

A governing factor is also found in the relation of the thickness to the breadth of the spring. The wider the spring the less power it loses upon being repeatedly called into use, whereas a narrower and too thick spring loses its expansive force very quickly. In every case, therefore, the width of the band of steel of 0.50 millimeter thickness should be at least 20-fold; of a spring gaging from 0.50 millimeter to 1 millimeter the width should reach at least 30-fold, and for any heavier gage the width should be at the very least 40 times its thickness. As a rule no springs are made of watch- or clock-spring steel wider than 120 millimeters nor thicker than 2 millimeters.

It has been found more expedient to employ two weaker springs placed in separate barrels rather than one of such abnormal dimensions.

With due consideration of the above rule the calculation of a motor-spring of the varying dimensions is very simple. The relaxed or run-down spring in the barrel represents a ring having its outer diameter equal to that of the barrel, while its inner diameter is equal to two-thirds of the same line. Now if we multiply, for instance, the mean diameter of the ring (which is five-sixths of its outer diameter) by 3.1416, and then by the sum of the turns, which may be very easily counted, we get the length of the band of steel.

The number of these turns may also be obtained by dividing the thickness of the strip into the thickness of the ring in its relaxed condition, which, according to the measurements given above, must always be one-sixth of the internal diameter of the barrel. If then a spring were made from a strip 1 millimeter thick and placed in a barrel with a diameter of 60 millimeters the length resulting from the following calculation would be 1.57 meters, viz.:

$$\frac{5 \times 60}{6} \times 3.1416 \times \frac{60 \times 1}{6}$$

Cleared from fractions this member of the equation becomes simply $50 \times 3.1416 \times 10 = 1.57$ meters. By a suitable transposition of the terms the thickness of the spring as well as the diameter of the barrel can be obtained from the length.

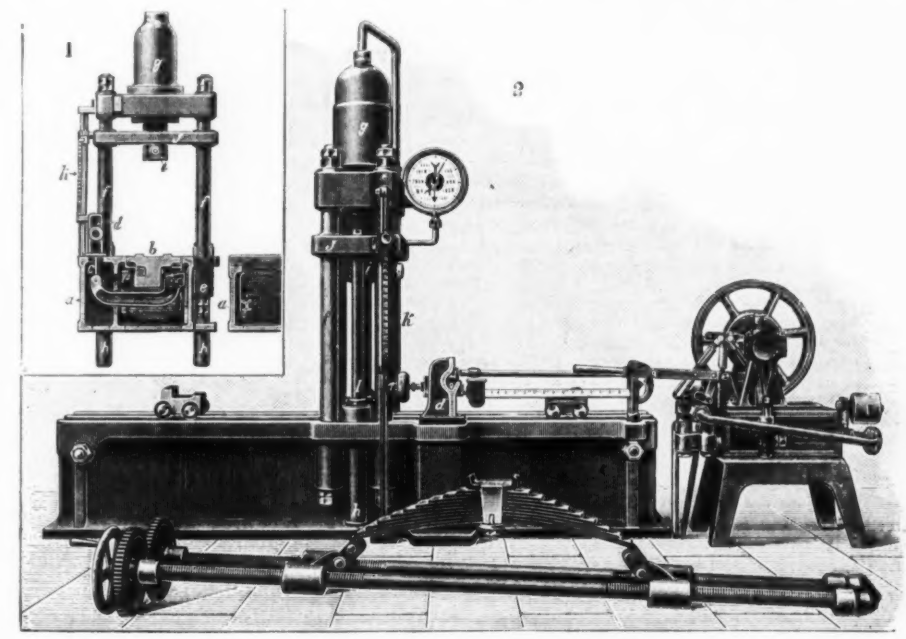
It is, however, difficult to determine exactly the number of revolutions that the barrel arbor will make before the spring is entirely run down, or has exhausted its expansive energy.

For this purpose the number of turns of the spring around the arbor produced by winding it up from its complete extension must be sought after, first determining the mean diameter of the ring when wound up; from this the thickness of the ring which is wound upon the arbor is readily found. Now take the thickness of the ring found by comparative calculation in millimeters and divide it by the thickness of the steel strip already obtained, and the quotient will be the desired number of turns.

Now calculate the number of turns of the relaxed spring as we have shown above by dividing the thickness of the spring into one-sixth of the diameter of the barrel. The difference between the two numbers of turns obtained in this way will give approximately the number of turns which the spring will force the arbor to make. The calculation of springs and corresponding trains of gear can of course not be demonstrated with such detailed exactness as to suffice for every instance. Accordingly the object of this communication will have been attained if an approximate conception of the governing principles has been gained.—From the German of Emil Riedel in the Allgemeine Uhrmacher Zeitung.

A MACHINE FOR TESTING SPRINGS.

THE accompanying engraving represents a machine that has recently been devised for testing large springs. It comprises, in the first place, a foundation consisting of a very long rectangular box of cast iron, the top of which is provided with tracks upon which run two small carriages that support the extremities of the spring to be tested. This box contains a series of levers upon which bears (or from which may be suspended if desired) the testing table, *b*. From the system of levers, which performs something of the rôle of a weighing machine, starts a vertical rod, *c*, which actuates a steel-yard, *d*, in transmitting the changes of level of the table to it. Into the solid steel projections, *e*, in the center of the box are bolted four strong steel columns, *f*, and to the top of these is secured by bolts the bed plate of the hydraulic testing cylinder, *g*. The piston rod of the latter is designed to operate in one direction only, that is, downwardly, so as to exert its force upon the spring to be tested. After the test is finished, and it is desired to raise the piston to its initial position, recourse is had to two



MACHINE FOR TESTING SPRINGS.

1. Section. 2. General elevation.

small auxiliary hydraulic cylinders, *h*, which are cast integrally with the lateral parts of the box. The water introduced thereinto drives before it the pistons, *l*, to the head of each of which is secured a transverse bar, *j*. The two bars, *j*, act in unison with the displacements of the rod, *i*, and, when they ascend, they raise the rod, *i*, and expel the water from the hydraulic cylinder, *g*, of which the orifices have been opened. Moreover, an automatic arrangement prevents the water from entering the small cylinder until after the said orifices have been opened. With the upper cylinder, the reverse is the case.

The machine registers the sudden compression through the spring tested. In order to reach such a result, a scale is arranged at *k* upon a vertical rod placed at the side of the compression apparatus and attached to the bed plate. This scale is so combined that it can be regulated, at the beginning of the operation, according to the type of spring to be tested. Moreover, the head of the hydraulic piston, as it descends, carries along with it a needle that passes over the graduated scale. This needle remains at the maximum point to which it has descended at the moment at which the compression piston begins its ascent, so that the maximum stress is thus registered. When it is desired to make a test, the weight of the spring is read upon the steel-yard, and the latter is then regulated in accordance with the compression that it is desired to exert upon the spring, and which corresponds to a total weight acting upon the apparatus. After this, the piston is made to descend along with the transverse bars, *j*, until the head touches the spring without compressing it. This level is taken as zero. The screw that normally maintains the graduated scale is then loosened so as to permit of bringing the needle opposite zero, and the scale is raised in such a way that the needle shall touch a tappet fixed upon one of the bars, *j*. The screw is then tightened up, and

when the manipulation of the compression pump is about to lower the piston and compress the spring, the tappet carries along the needle until the steel-yard indicates that the total weight or the desired compression has been reached.

The operator throws the apparatus into or out of gear and opens or closes the various valves by means of a single lever. The rods with double thread perceived in front of the machine permit of mounting the springs for tests under variable conditions of tension and inclination of the couplings of their extremities.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE STRUCTURE OF THE ATOM.

THE highly suggestive lecture on the "Structure of the Atom," delivered by Prof. J. J. Thomson, at the Royal Institution recently, is a useful reminder that in spite of the recent decision on the subject of compulsory Greek, Cambridge has not yet degenerated into a mere home for lost causes, but continues to be the leading school of mathematical physics in Europe. In justice to the eminent men who have made the name of Cambridge of international renown, it is only fair to point out that the regrettable decision was due in the main to the influence of the country clergymen, whose academical honors seldom extend to more than a second-class in the tripos, though their voting power is the same as if they had all been senior wranglers. Up till recently the lack of equal advantages elsewhere for the study of science has limited the number of good men, who have sought equivalent training elsewhere, rather than waste their time in satisfying the requirements of the "Vicar of Little-cum-go"; but in the absence of reform, the number of these is certain to increase in the future. In the meantime, however, so long as men of Prof. Thomson's originality direct the study of physics at Cambridge, this diversion of good raw material in the shape of undergraduates will be minimized.

In opening his lecture, Prof. Thomson said that eight years ago he had brought before them evidence of the existence of negatively electrified particles much smaller than atoms, having a mass equal in round numbers to about 1/1,000 that of the hydrogen atom. A very suggestive fact concerning these particles was that they appeared to be identical, whatever the source from which they were derived. They were first found in highly exhausted tubes traversed by electricity, and were afterward proved to exist in the neighborhood of incandescent bodies, and of radioactive matter, and in that of metals exposed to violet light. However derived, they appeared to be always the same; a fact which, in conjunction with their small size, suggested that every atom might be constituted by a group of these corpuscles. He proposed therefore to discuss that evening what the properties of an atom would be if built up of these negatively electrified particles. Since they were all electrified negatively, they tended to repel each other, and hence if an atom was a structure built up of these as the bricks, something further must be present to serve as the mortar to bind them together. This could only be positive electricity. Unfortunately, very little was known as to the nature of positive electricity, which was never found associated with particles of less than atomic dimensions. This fact might be taken into account by assuming that the positive electricity occupied a sphere, inside of which the negative particles grouped themselves, a balance being struck between the mutual repulsion of these particles for each other, and their attraction to the center of the sphere of positive electricity. If the number of particles was small, the position they would occupy could be easily calculated. A single negative particle would occupy the center of the sphere. If there were two particles, these would group themselves at opposite sides of a line through the center of the sphere, and having a length equal to the radius. Three particles would occupy the apices of an equilateral triangle, the side of which was equal to the radius of the sphere; while four particles would occupy the corners of a tetrahedron, and with five the distribution was the same, with a single particle at the center. Six particles grouped themselves at the corners of an octahedron, but with seven particles a new departure was manifest, since these did not group themselves at the corners of an octahedron with a single central particle, but as a ring of five particles, with a single particle on each side of the plane of this ring. With eight particles it was natural to expect them to occupy the corners of a cube; but this arrangement was unstable, and the actual arrangement was at the corners of an octahedron, with two particles inside this at opposite ends of a diameter. Here was evidence of the beginning of an outer shell of particles.

The results stated were obtained by calculation, and he had carried this as far as a determination of the grouping of twelve particles; but with large numbers the calculation became troublesome, especially that concerning the stability of any proposed arrangement. The matter could, however, be carried further by experimental means, making use of floating magnets as suggested by Prof. Mayer. These were magnetized needles caused to float vertically in water by sticking them through fragments of cork. The pole of a large magnet below the surface served to represent the mass of positive electricity. The attraction of the floating magnets to the central point varied then nearly directly as the distance. Throwing into a basin thus arranged five of the magnetized needles, these arranged themselves at the angles of a pentagon, while six did not form a hexagon, but a pentagon with one in the middle. A heptagon of seven was unstable, the stable form being a hexagon with the seventh at the center. With greater numbers, outer and inner rings were formed; the number in the outer ring could, however, only be a certain proportion of the total, and to get a large number in the outer ring a very large number must be at the same time included inside this ring, as shown by the figures annexed:

Number in outer ring	5	6	7	9	10	12	13	15	16	19	20	21	40
Minimum number inside ...	0	1	1	2	5	7	10	15	20	36	39	47	232

From this it was evident that to get a large number of particles outside the total number necessary increased enormously.

From the table it was possible to see how any number of particles chosen at random would arrange themselves. Thus, if the number was 20, it would not be possible to have 13 outside, as this would need 10 inside, making a total of 23. The arrangement therefore could be 12 outside, and the remaining 8 would form an inner ring of 7, with one at the center. The table, of course, referred merely to particles in a plane, while the actual negative particles could move in three dimensions; nevertheless, the properties in the more complicated case would be quite analogous to the distribution in a plane, as stated.

The group of 20 constituted as described might be looked at as formed by adding another "storey" to the group of 8 particles. Similarly, 16 outside particles would be stable with 20 inside, and to this could be added an additional ring of 19, so that by adding "storey" to "storey," or ring to ring, a series of "atoms" could be built up. It was reasonable to suppose that "atoms" built up in this way would possess some properties in common, or that certain properties of an original group would reappear on the completion of an additional storey. This would be something equivalent to the periodic law, if the number of particles forming the atom was taken as proportional to the combining weight.

Starting from lithium and taking the elements next in order of combining weight, certain properties of the lithium only reappear when sodium and, later on, potassium are reached. The way in which other properties might vary with the number of particles—i. e.,

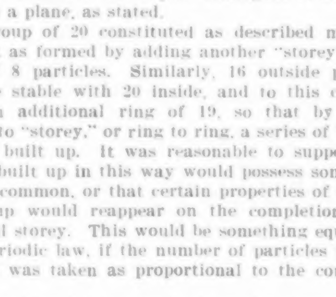


Fig. 1.

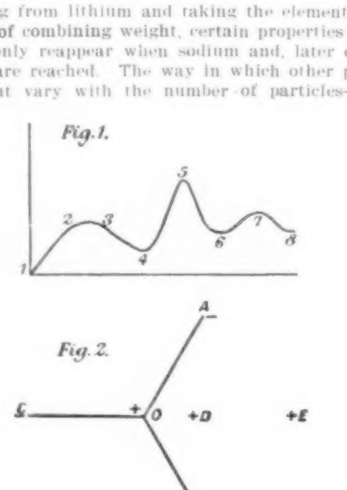


Fig. 2.

with the atomic weight—could be illustrated by the model. Thus, taking the case of 59 particles. These might have 20 in the outside ring and 39 inside of this. Adding one more particle, an arrangement of 21 outside would need 47 inside or 68 in all, so that with 60 particles the stable form had there 20 outside and 40 inside. The greater the number of particles inside the more stable the arrangement, and hence the "atom" of 60 particles was more stable than that of 59, which, having the minimum necessary inside, would easily lose a single negative particle, so that the atom represented by it should be strongly electro-positive. When, however, the particles were increased to 68, the number inside, being 47, is again a minimum; and hence this group should again be electropositive, while the addition of fresh particles would make it more and more electronegative till another minimum arrangement was reached, when there would be a sudden and abrupt change to an electropositive arrangement. Taking the series of elements Li, Be, B, C, N, O, and F, these became more and more electronegative as the combining weight increased; but at the next step—sodium—there was a "jump," that element being strongly electropositive, just as occurred on increasing the number of particles in the model atoms.

Real atoms, on the view put forward, consisted of positive electricity and negative corpuscles. On this view, transformations of the atoms might occur, but the direction of this transformation depended upon the nature of positive electricity. On one view, as to the latter, the universe originated in separate particles, which aggregated to form existing atoms, while on the other it started as a single mighty atom, from which those now existing have disintegrated. Were the transformations now occurring taking place in the direction of greater simplicity or in that of greater complexity? If the answer was sought in the constitution of the model atom, there was a difficulty, since the direction of the transformation depended on the real nature of positive electricity, of which almost nothing was known. The point turned upon what happened when two of the spheres of positive electricity came together. If the positive electricity acted as an incompressible fluid, so that the resultant volume was double that of either constituent, then matter began as a single simplex atom, and had been transformed down into the existing atoms. If, on the other hand, the volume of the sphere of positive electricity was constant, two units coalescing to form one of the same size as either of the original spheres, then the evolution had taken place in the opposite direction, and the final stage of the universe would be a single gigantic atom.

Even if the point in question were left open, there were a few features common to both courses of evolution. Prof. Thomson had calculated the arrangement of particles in stable equilibrium up to the number of 12. The potential energy of such model atoms varied with the number in the group, but not uniformly, the curve having the general shape shown in Fig. 1, consisting of a number of hills and valleys. The number 5 was at the top of a hill, while 6 was at the bottom of a valley. The corresponding atoms might be likened to stones resting, some on hills and others in valleys. The former, if disturbed, would roll down the slope, while the equilibrium of those in the valleys was stable. Hence in the evolution of the atoms those occupying crests on the curve of potential energy tend to disappear, and the stable elements collected at the bottom of the valleys, so that, as in biological evolution, many missing links must be expected.

The forces with which atoms acted on each other, and the kind of aggregates that were permanent, remained to be discussed. The problem might be compared to that of the stability of a gravitational system, the general solution of which had not yet been attained. There was not even agreement as to the stability of the solar system, though the general opinion of astronomers appeared to be that it was unstable, but that we should never live to find it out. Maxwell had made a very remarkable contribution to the discussion of this subject in treating of a system like that of Saturn, and determining the stability of a system of satellites following the same orbit, and equally spaced therein. He had shown that for such a system to be stable the planet must be enormously bigger than the satellites. Taking the case of the earth, five moons of the same size as the actual one might be spaced equally apart in the same orbit and the system would be stable; but with six moons instability would arise; so the earth might in a way be said to be "saturated" with five moons. Similarly, a given chemical element will combine with a certain number of other elements only. This peculiarity was not dependent on any special law of force, but held for a great number of different laws.

The forces between the atoms arose from attractions and repulsions between electrical charges and were of two kinds—electrical and structural. The system would be unstable if the atoms and the charges were at rest. The theorem applied, however, only to a state of rest, and not to steady motion, and, moreover, the other forces might come into play to check the instability. Thus, if the corpuscles were moving in the atom, a magnetic field would be generated round the axis of rotation, and electrified particles would then have great difficulty in crossing these lines of magnetic force.

For the combination of two atoms, he had found that it was necessary for stability that the attractive force should increase as the distance increased. This effect might be the result of the combined action of the negative particles and the positive nucleus. For example, with a system such as that represented in Fig. 2, consisting of a central positive charge, surrounded by three equally-spaced negative charges, the action on a particle of positive electricity placed at *D* would be a repulsion, since the two negative charges at *A* and *B* would neutralize each other, and the central positive charge being nearer to *D* than was the remaining negative one, the resultant force would be a repulsion. With the positive charge at *E*, however, the total attraction due to the three negative charges would overpower the repulsion of the positive charges, so that the resultant force would be an attraction. At some intermediate point equilibrium would be established. The nature of the reactions resembled those obtaining on Boscovitch's hypothesis, the attraction between two masses becoming a repulsion when the two were less than a certain distance apart. It differed, however, in that the phenomenon in question was apparent only along certain axes, since a particle placed in the direction *O B* would be repelled whatever its position. Still more complicated models could be schemed, showing two positions of equilibrium.*

In such a case as this the equilibrium depended on one of the atoms being electrified, but similar relations were also possible between non-electrified atoms. He would show an experiment to illustrate the fact that two uncharged atoms might repel each other when near together, and attract when further away. Thus the force between the atoms in the molecule might be divided into two types—the first, which might be called the "E" type, depended on the atom having an excess of positive or negative electricity; the second, the "M" type, being independent of the charge, and depending only on the structure of the atom. He thought the "E" type mainly instrumental in holding atoms of different kinds together, the "M" type atoms of the same kind. Taking such a compound as marsh gas CH_4, it might be asked, Were the atoms charged? It was very difficult to give a direct answer, but indirect evidence led to the belief that in similar cases they were charged. For example, certain compounds rotated the plane of polarization even when not in the crystalline state. Such a rotation was easily comprehensible if the atoms were charged, but otherwise it was difficult to account for the phenomenon, and especially for the magnitude

* A model showing the phenomena in question was exhibited by Prof. Thomson at the meeting.

the effect. Further, the spectra of compounds, if the atoms were not charged, should be simply related to the spectra of their constituents. This was not found to be the case. In short, two kinds of force were in question—one depending on the charges, and the other on the structure of the atoms; the former being generally the more important. From a chemical point of view, in those combinations in which the forces acting depended on the charges, it should be possible to substitute a similarly charged atom of another element without much disturbing the architecture of the compound as a whole. If, on the other hand, the hydrogen atoms in marsh gas were held by structural forces, the substitution of one by another element would alter the whole system, and was thus a much more serious matter.

With atoms built up as suggested in Fig. 2, the forces capable of holding another atom in stable equilibrium would be developed in certain directions only. These directions might be named "valency regions," and the general result would agree well with the hypothesis of Van t'Hoff and Le Bel as to the asymmetrical carbon atom, which they supposed to exert attraction in four definite directions. In parallel with this view, it appeared from the model atoms that in certain regions only would another atom be in stable equilibrium. The chemist assumed that the attractive forces were confined to certain regions only, while the speaker suggested that the atoms exerted attractions all round, but in certain directions only could another atom remain in stable equilibrium.

If two similar atoms were brought together so that one valency region of one lay close to one on the other, these two regions would be uninhabitable for other atoms, but the remaining valencies in each would be available. Compounds of this class would be represented by $H_3C — CH_3$. If two valency regions on each coincided with two in the other, compounds of the class $H_2C — CH_2$ alone would be possible; and, finally, if three valency regions on each lay close to three on the other, but one valency region on each would be available, giving rise to compounds such as HC — CH. In such cases the carbon atoms were held together by the structural forces already referred to.

RAILWAY RATE REGULATION. ITS BEARING UPON PUBLIC TRANSPORTATION.

By James L. Cowles.

"Our present system of making railway rates is taxation without representation in its most dangerous form."—(Charles A. Prouty, Interstate Commerce Commissioner.)

So vital has become this question of "Taxation Without Representation," that a special session of Congress is to be called for its consideration this fall. All the various railway-rate bills hitherto presented, however, leave the present system of rates still in force, and continue its application in the hands of the same irresponsible forces.

In view of past experiences, it seems to be very clear that only by the primary determination of rates by Congress can the present evils be remedied.

Public transport rates are taxes levied for the support of post-roads, railroads, trolley lines, public highways. If a free, representative government is to continue in this country, these taxes should be levied, primarily, by the representatives of the public in their various public assemblies. The common welfare demands, moreover, that the transport tax be determined on the cost-of-the-service principle, regardless of distance, and that the tax be low, uniform, stable, the same for all persons and all places.

From the foundation of the national government, Congress has always regulated the transport tax on the circulation of intelligence; letters, newspapers, periodicals. In 1863, while still engaged in the struggle for the overthrow of slavery, Congress adopted the principle of uniform postal rates, regardless of distance, and thus guaranteed forever equality of postal rights and privileges throughout the republic. This act also extended the postal service to the transport of a few articles of merchandise in eight-ounce parcels.

In 1870 Senator Sumner, of Massachusetts, congratulated the Senate that, slavery being dead, one more step might well be taken in behalf of a wider liberty by the establishment of a uniform one-cent letter rate.

In 1872 the postal service was extended to cover general merchandise. In 1874 the eight-ounce merchandise weight limit was increased to four pounds, with a rate of one cent for each two ounces, which is one-half the tax now levied on merchandise.

In 1885 Congress provided that publishers' merchandise, newspapers and periodicals, should be transported from postoffice to postoffice throughout the country at the rate of one cent a pound; this in parcels unlimited by law either in size or weight and only limited in practice by the size of the conventional mail sack parcels, from a pound to 200 pounds. And where free delivery exists (save, curiously enough, in the cities of publication) this merchandise is distributed to the customers of publishers and newsdealers, by the piece, without extra charge.

The publishers' post offers a striking object lesson as to a practical method of protecting the private citizen and the general business interests of the country against the unreasonable and uncertain transport rates exacted by the managers of our public transport corporations—a striking object lesson as to the right solution of the railway-rate problem.

In this case the public corporation, the Congress of the United States, stands between the transport corporation and the citizen, determining at once the payments to be made by the government to the transport corporation for its service and the tax to be paid by the citizen to the government for its service. The corporation certainly secures its full dues. The smallest publisher and newsdealer pays the same tax, and receives the same service as the largest publisher and the largest newsdealer. Any newsboy can arrange with the government for the transport of his merchandise on as good terms as the largest news company. The publishers of Augusta, Me., are as well off as to the transport tax levied on their produce as are the publishers of New York, Chicago, or San Francisco.

Once Congress has extended to the whole public the protection now enjoyed by publishers and newsdealers, discriminations in transport rates will disappear. All classes of persons and of business and all places within the established postal system will receive their supplies and send off their produce on equal terms as to transport taxation.

This does not necessarily require the government ownership or even the government management of transport agencies. The running of railroad trains, the construction and reconstruction of railroads and allied services, the employment and discharge of transport employes, may still be left in the present control. The sole loss to the railroad manager will be his power of irresponsible taxation, his power to give rebates, to enrich or ruin persons and places at his will. Henceforth he will deal with the public, not individually but *en masse*, in the person of the great public corporation, the United States government.

Congress already authorizes the Postal Department to hire mail cars. If contracts can be made for the use of a part of the public transport equipment, similar contracts can be made for the whole equipment, or any part of it. Every vehicle engaged in the mail service is necessarily engaged in interstate commerce, and is therefore subject to Congressional jurisdiction.

The terms of these transport contracts may be very simple, so much per mile for the flying space, so much per mile per vehicle whether full or empty.

The reason for this common rate is clearly stated in the following quotation from a paper on "Railway Mail Pay" by Vice-President Clough, of the Great Northern Railroad: "What costs the railroad company is space flying through the air, and this space costs the company nearly the same, regardless of how it is occupied."

The extension of the postal principle to general transport rates by the national government would be little more than the establishment, as a general law, of what has long been a common custom in interstate railway practice. It would insure stability of rates, freedom from discrimination, the possible reduction of transport taxation as improvements in transport machinery reduced the cost of the service rendered.

In an extended postal service we find at once the solution of the railway-rate problem and that irresistible guarantee of equal rights to all which is the glory of the republic.

THE STANDARDIZATION OF CHEMICAL ANALYSIS.

The need of some system whereby chemical analysis may be standardized has been made the subject of exhaustive treatment by Dr. W. F. Hillebrand and Mr. Clifford Richardson. It is nothing new for chemists to differ in the analyses of the same material, and they will never cease to differ by reason of human fallibility and the limitations of all analytical methods without exception, but unless two chemists are able to assay or analyze the same sample with results acceptable as a basis for buying and selling, the analysts suffer in the estimation of those interested in the transaction. If similar want of accord is of frequent occurrence, the burden of blame may be shifted and the art of analysis, even the science of chemistry itself, fall into disrepute among the unthinking. In any case the matter is one of grave concern in many ways, and merits the serious consideration of chemists as a body.

We may analyze the causes for the variations shown in the analyses of the same, or supposedly the same, samples, and, neglecting the inevitable personal factor, find that in certain cases the sampling was incorrect, in others that the water was bad, the reagents faulty, their effect on the glassware used greater than had been suspected, or that of several methods for reaching the same end one or more are of doubtful value unless used with that knowledge which can only come of long practice, sharpened by discriminating judgment. But in the ultimate analysis these distinct causes nearly all lead back to one stem root, some defect in the early education of the chemist, for which the institutions that are yearly sending forth young chemists supposedly fitted to do good work in their chosen lines, are responsible.

It will, of course, be asked: In what respect have their instructors failed toward these young men? A definite and comprehensive answer to this demand it is out of my power to give. The teaching of incorrect methods is neither wholly nor in large part to blame. The faults, if faults there be, are rather those of omission than of commission.

Many inquiries addressed by Dr. Hillebrand to the participants in one series of analyses elicited the information that few knew anything definite about the quality of the water they were using, though examination showed it to be bad in a few instances, and on the border line in others. Still less was known as to the quality of the reagents, except that they came from reputable firms. One admitted that a flaky sediment showed in his ammonia bottle, but he used only the clear liquid above. If the sediment represented silica from the bottle, as may well have been, what had become of the other constituents of the attacked glass unless they were in solution?

Is a student ever required to find out by actual test how good his water is, and both the kind and amount of its contamination, if such there be? Is it customary to instruct him in the testing of his reagents and as to the character of the contaminations to be looked for in all of the more important ones, or is he allowed to go forth with the impression that the label C. P., while not a flawless title, is a sufficient guarantee for all the demands of technical analysis? Is he, in fact, ever cautioned to find out, by actual test, the errors with which his work may be affected, due to imperfections in his tools of the kind just mentioned? And that without such knowledge and the ability to make correction for the defects, or the courage to fight for better materials with which to do, he will occupy a false position with respect to himself, his employers and the community at large?

Only by such exercises can the young worker gain any knowledge as to his own power to do good work, and acquire that proper confidence in himself which is so essential.

There is in many of our institutions woful lack of supervision of the work of each individual student. There are hundreds of little tricks of manipulation which the student cannot learn for himself, and which he should be taught by a conscientious assistant, having little to do but devote his whole time to a limited number of workers. This brings me to the remark that no laboratory instructor should be required or allowed to do outside work, either for his superiors or himself, so as to encroach in any way upon the time that should be given to those under his supervision. This would necessitate a very decided increase in the corps of instructors, so as not to deprive them of opportunity for research work. Once the fundamentals have been mastered, the worker, correctly started, may well be left more to his own resources, but even then he should receive frequent visits for the purpose of guarding against relapse from right ways, for giving needed additional information, and answering the proper queries that are pretty sure to occur to a good student. It is far better that the student should learn to do comparatively few things thoroughly, mastering the whys and wherefores of every step, than a great many superficially and without acquisition of the underlying principles. It is only the one thus thoroughly grounded who is in a position to use or devise short cuts without great danger.

OCCUPATIONS OF THE PHILIPPINE ISLANDERS.

A majority of the Filipinos farm small tracts of land, and those living near the coast alternate this occupation with fishing. The women divide their time between duties of housekeeping and the weaving of hats, mats, and cloths, and are, therefore, included among those engaged in gainful occupations. This fact accounts for the excessive proportion of wage-earners, who form no less than 43.5 per cent of the civilized population. The number of female wage-earners in the Philippines is proportionately double that of the United States and three times that of Porto Rico and Cuba. Of the female wage-earners, nearly 70 per cent are returned as manufacturers, and the proportion engaged in agriculture and domestic service is much less than the corresponding proportions for the United States. Of the male wage-earners, more than half are employed in agricultural pursuits, and so few are returned as manufacturers that the proportion of women employed in those pursuits is so large as to show that it is practically a line of feminine employment.

Farmers and farm laborers constitute more than two-fifths of all who are engaged in gainful occupations. A much smaller proportion are engaged in manufacturing and mechanical pursuits, while the number in professional service is exceedingly small, forming less than 1 per cent of the entire number gainfully employed.

Among the Filipinos themselves there are 1,326 physicians, 676 priests, and 727 lawyers. Nearly one-half of the Chinese wage-earners are merchants or salesmen. Of the foreign or white population a small proportion are engaged in agriculture, but most are found in the trades and professions.

Sixty per cent of the population of the city of Manila are employed in gainful occupations. This rather remarkable proportion appears to be due to the fact that the foreign element is very large and the proportion of young children, small. The figure, however, is much greater than for any considerable section of the United States, the closest approach being in the State of Wyoming, where the proportion of persons gainfully occupied was 47.8 per cent.

While it is probable that the part played by bacteria is not so important in the ripening of cheese as formerly supposed, the necessity for the lactic bacteria in acidifying the milk for the production of a good curd is well recognized. We also know that in some kinds of cheese molds are essential to produce the characteristic flavor so much relished by some. In addition, the supplying of certain bacteria, known as "langvey" in Holland, plays a most important part in preventing the deterioration of the cheese, owing probably to these organisms keeping down the growth of objectionable forms by exhausting certain necessary food products. This latest discovery is likely to open up a new field in the dairy industry, as, in a sense, it does away with

the necessity of keeping out all deleterious organisms, and permits a good product under conditions which otherwise would make it impossible to manufacture cheese at all.

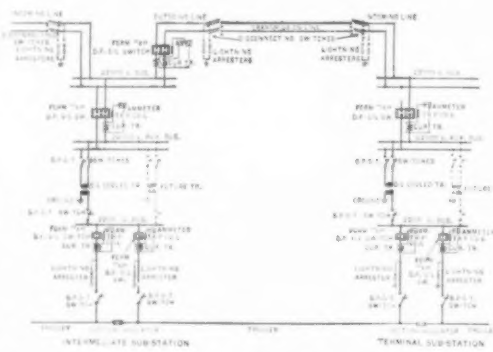
A NEW SINGLE-PHASE RAILWAY EQUIPMENT.*

By A. FREDERICK COLLINS.

IN Europe there are several electric railway systems in operation that are using three-phase alternating currents, while it is well known that here in America engineers have held long and lovingly to the direct-current system. Naturally, these opposed conditions have been the cause of more or less discussion in railway circles at home and abroad.

Three-phase railway systems are not by any means a new and untried feature in traction work, but they have stood the test of time since 1895; three years prior to this date Siemens & Halske, of Berlin, Germany, conducted the first tests at Charlottenburg on a short length of road with two overhead trolleys, the rails forming the third conductor, when cars were operated by a 600-volt, three-phase current at 50 cycles.

Then Brown, Boveri & Co., of Baden, Switzerland, put into service an alternating-current system when they completed the Lugano tramways, the first ever installed for commercial use. This has been in operation ever since 1895, and the success of this installation led to the construction of the Gornergrat railway, per cent, and three-phase current at 7,000 volts and 38 cycles, generated by the water-power developed at the White Lutschine, is transmitted by overhead wires to transformer stations, which are located every 1,000 yards, where it is stepped down to 500 volts. Then there is the Burgdorf-Thun railway, which forms an important link between three of the main steam lines

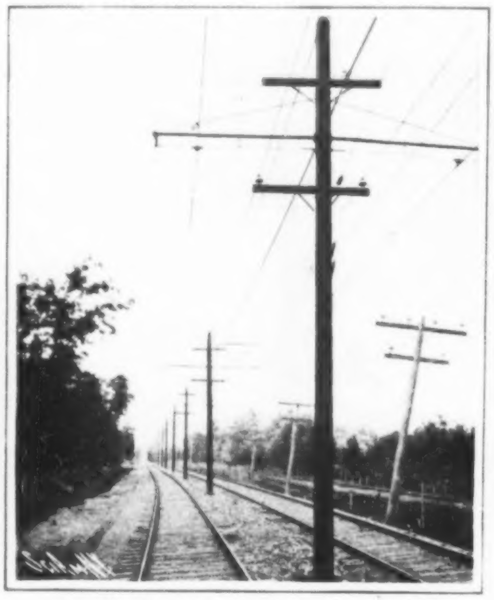


POWER DISTRIBUTION SYSTEM FOR SINGLE-PHASE RAILWAY, SINGLE-PHASE TRANSMISSION. SINGLE TRACK.

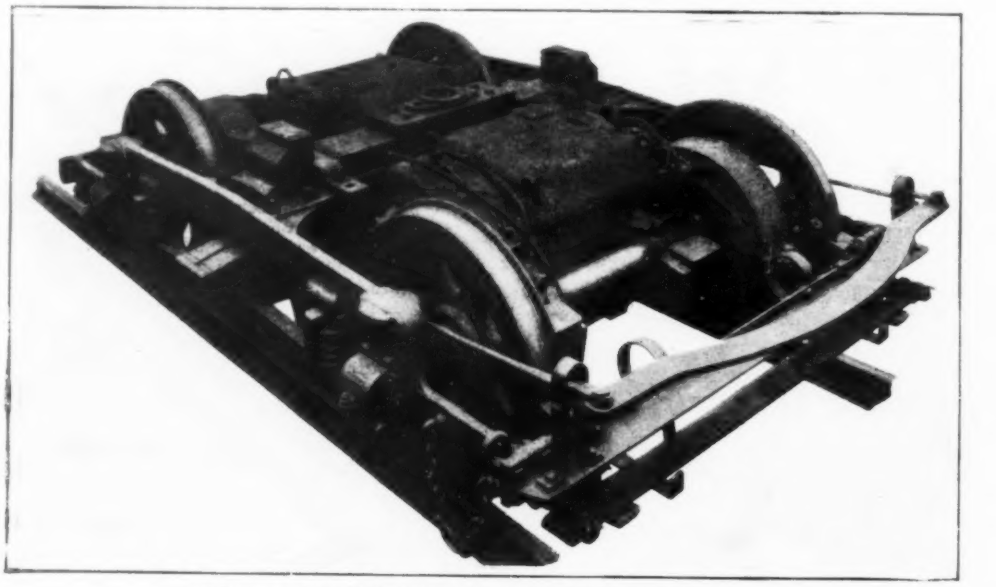
motor, especially where the profile of the track is irregular, and the cars have to make frequent stops; again the rate of acceleration of cars operated by three-phase current motors is low when compared with the acceleration of direct-current motor cars; and further, where induction motors are used, a large amount of current is required in starting, although since the current and voltage are not in phase, the total energy consumed is relatively small.

Opposed to these outward features are numerous advantages, the principal ones being the elimination of sub-stations, where rotary converters change the alternating into a direct current, which on railroad lines are essential; the ease with which a high-potential current can be stepped down by a stationary transformer on the car, and the economy with which long-distance transmission can be effected. American engineers have followed zealously the developments of the multiphase induction motor for traction work, and have been fully aware of its limitations as well as its possible extensions.

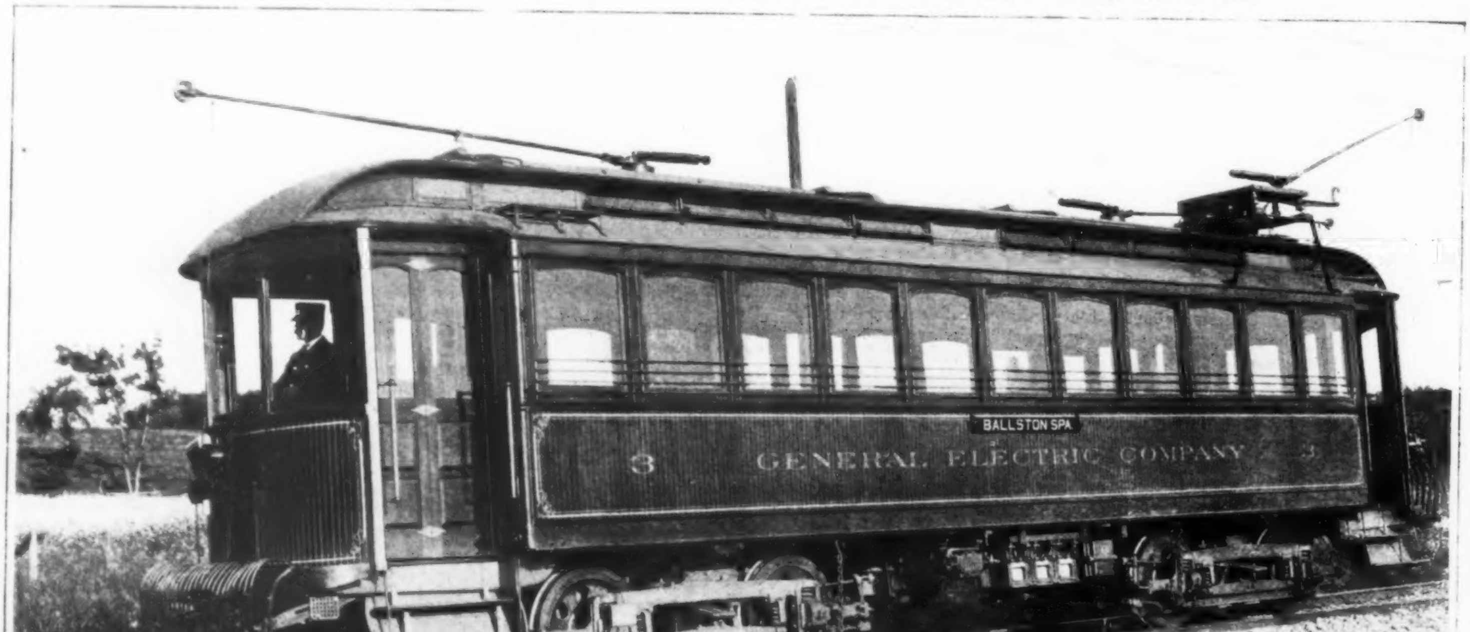
For several years past the engineers of the General Electric Company have bent their energies toward a safe and sane solution of the problem, and as a result they have devised a type of single-phase alternating-current equipment suitable for general traction work. The motor under consideration fulfills the exacting conditions imposed by the railway service, but what is yet more striking is its ability to operate on an alternat-



OVERHEAD CONSTRUCTION OF THE LINE.



THE TRUCK OF THE ALTERNATING-CURRENT MOTOR CAR.



ALTERNATING-CURRENT MOTOR CAR, BALLSTON LINE.

NEW SINGLE-PHASE RAILWAY EQUIPMENT.

and it was here that the Swiss engineers felt that they had achieved a signal success, for the road was considered a difficult test, having grades with a maximum rise of 20 per cent.

More celebrated than either of these is the Jungfrau railway, where some grades attain a maximum of 25

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

of Switzerland; the Valtellina line in the northern part of Italy; the Zossen road, on which the high-speed electric tests took place, and a number of others.

In the face of these demonstrable facts, our home engineers have shunned polyphase currents for traction purposes, for the reason that the induction motor is considered less economical than a direct-current series

ing current or a direct current with the same facility and economy, hence its wide range of usefulness and adaptability to direct-current trolley systems in cities and interurban extensions using alternating-current lines.

This single-phase compensated motor equipment is now in operation on the Ballston division of the Sche-

tady railway, and is the first alternating-current railway in this country carrying passengers, demonstrating absolutely the feasibility of using a direct-current system within the city limits and a single-phase current on the line to Ballston.

The alternating-current motors employed are known as the compensated type, so named in virtue of the character of the field winding, which fully neutralizes or compensates for the armature reaction. Both the compensated motors and control are designed for operation on the 2,000-volt alternating-current trolley between the two cities and the standard 600-volt direct-current trolley in Schenectady.

The compensated motor is essentially a variable-speed motor, differing in this respect from the multiphase induction motor, whose constant-speed characteristics caused it to be looked upon in this country as a serious handicap to its successful employment in railroad work. The speed-torque characteristic of the compensated motor is very similar to that of the direct-current series motor, while its commutating qualities and method of control have proven equally satisfactory.

In construction the compensated motor consists of an annular laminated iron field with a distributed winding similar to that of an induction motor, and an armature provided with a commutation similar in general mechanical design to that of a direct-current railway motor. Motors of this type are wound for 200 volts, are permanently connected two in series, and are fed from the 400-volt secondary of an 80-kilowatt air-blast, step-down transformer which is carried on the car.

The distributed character of the field winding fully compensates for the armature reaction, so that the power factors are relatively high throughout the range of operation; moreover, it is so designed that at the free running speed of the car, which is the condition most frequently met with in suburban work, the power factor and efficiency are nearly at their maximum values. A high power factor is desirable, as it reduces the capacity and cost of the generating and distributing systems, and more especially effects a material improvement in the regulation of the alternating-current generators.

Unlike a direct-current system, which has a practically constant potential at the sub-station bus-bars, irrespective of the load, the drop in an alternating-current railway system is cumulative up to and including the generator and engine regulation. It is desirable therefore to maintain as good a power factor as is consistent with good motor design, in order to limit the total drop of the system to a reasonable amount.

Motor characteristics that have been plotted for both alternating and direct current running show that the speed torque for alternating-current running is equal to direct-current running in meeting the requirements of railway work. Different from the multiphase induction motor with its practically constant speed characteristic, the compensated alternating-current motor varies its speed with its load, and is thus better adapted to operate trains over an irregular profile.

The commutation of the compensated motor is satisfactorily secured, when running on either alternating or direct current, by careful electrical and mechanical design, and without resorting to high-resistance leads, and other expedients which are likely to give trouble in case of a sustained overload. There is a comparatively small additional expense attached to adapting alternating-current equipments to run either on single-phase or direct currents, and in the Ballston line installation it is accomplished by the use of a standard K-28 direct-current series parallel controller used in connection with a commutating switch to change the field connections and line fuses and cut out the step-down transformer.

The arrangement of these connections is shown in the accompanying diagram. The commutating switch is interlocked with two main oil switches, one for the high-tension alternating current, and the other for the direct-current circuit, the interlocking being so arranged that only one switch can be closed at a time, and the commutating switch can only be thrown when the oil switches are in the off position.

With equipments operating on both alternating and direct current power, it has been found preferable to utilize the standard series parallel controller, in order to minimize the weight of the controlling apparatus. Such a method of operation does not give quite so high an efficiency when accelerating the car with alternating current as could be obtained with a potential control. This difference in efficiency, however, is very small, due partly to the infrequency of stops occurring upon those sections of the road equipped with alternating-current trolley, but chiefly it is due to the flexibility of the speed-torque curve of the single-phase motor, which gives a high efficiency of acceleration with series parallel control.

It has been found necessary on the Ballston line to provide double sets of trolleys, one for the alternating and the other for the direct current. The alternating-current trolley construction is off center, while the standard city and suburban trolleys are arranged directly overhead, hence the necessity of interlocking oil switches and commutating switch to prevent trouble, should both trolley poles accidentally be up at the same time.

The commercial development of the single-phase motor is opportune at just this time, as steam railway managements are displaying great activity in acquiring competing electric roads, and in electrifying certain portions of their systems which are now operated at a loss with steam locomotives.

PREPARING THE SOIL FOR PLANTING.

PICKING HOP BLOSSOMS IN A FOREST OF HOP VINES.

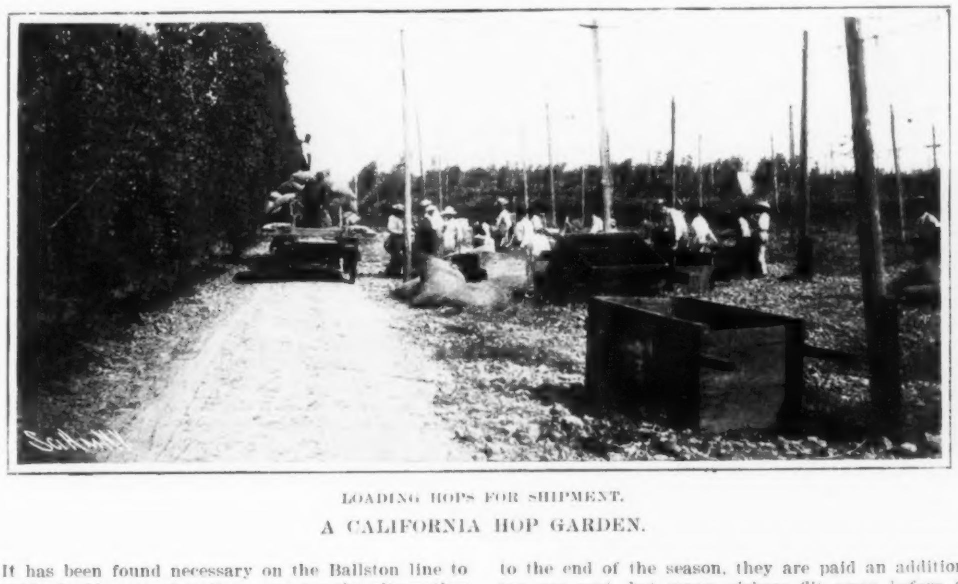
A CALIFORNIA HOP GARDEN.

By Janet Macdonald.

Five hundred and thirty acres of verdant beauty in the lowlands of California's golden heart, miles of swaying verdure in the sunlit region of prosperity and contentment, hundreds of willing hands and happy faces, the ringing laugh of childhood, the sonorous tones of middle age mingling with the subdued tones of later life engaging in healthful and profitable employment—this was the scene of Arcadian simplicity which greeted my vision in a recent visit to a California hop garden in Yuba County. Impressive as an object lesson looking to development in a country so richly productive and so easily tilled, and which will give profitable employment to so many people.

The yield in green hops in this garden alone amounted last year to more than three million three hundred thousand pounds. The picking alone of this prodigious crop cost $34,000, requiring the services of fifteen hundred people for twenty days. As hops ripen at different times in different localities in this highly diversified climatic State, hop pickers pass rapidly from one garden to another, usually putting in the entire season in this pleasant and profitable employment. Among them is numbered a conglomerate mass of humanity. "All sorts and conditions of men," women, and children are here represented. College professors, students of both sexes, and various nationalities, eager to earn the money with which to carry on their ambitious educational aspirations, and sober-faced men and women of good families, with their children of tender years, Japanese of both sexes, Chinamen, as well as entire families from sunny Italy.

Those pickers, irrespective of nationality, who are industrious, and deft of fingers, and *who are picking hops for every cent there is in it*, will make as much as $75 in the season of twenty days. If they work to the end of the season, they are paid an additional ten per cent, but many pickers flit away before the entire crop is gathered in, finding fresh fields and pastures new, where picking is easier, and they can therefore work more rapidly. A family of even mod-



LOADING HOPS FOR SHIPMENT.

A CALIFORNIA HOP GARDEN.

est proportions can clean up a nice bit of money, for a small tot can pick hops. The hop districts—for the gardens are districted—must be picked clean before another district is allotted. Natural selection is exemplified in the crews who work together, and social lines are strictly observed, but not only individual pickers, but entire families, return year after year to assist in the harvesting season. Hops are planted from slips, and when once growing healthfully, no change of plant is necessary, except for the gradual process of filling up the place of plants that have died, or in the case of securing better varieties, or those ripening in more convenient succession. The ground is plowed and harrowed, and every individual clod of earth is subjected to the most rigorous demolition until the ground presents a smooth, unbroken surface. It is manured, summer and winter; and the manure, like all the material used in the propagation and preparation of hops for the market, including string, hop cloth, sulphur, etc., is purchased in car-load lots.

The vines run on cotton twine, supported by wire trellis; two wires are used, and are supported by redwood poles twenty feet in height, one wire being placed at the top, and the other about six feet from the ground. The poles are set in rows, about forty feet apart one way and about fifty the other. In planting hops, a male vine is planted every tenth hill. It blooms, and scatters its pollen, when it has accomplished its mission, and is torn down with the female or bearing vines when the crop is gathered. A most remarkable thing in the twining of the hop vine is that *it must be twined with the sun;* for if, in the elementary work, it is started the wrong way, it doggedly refuses to go in that direction, but turns its face and follows the proper course. On the other hand, if a morning-glory vine be planted in the same hill, it is just as persistent in going around the support in the opposite direction, or *from the sun.* When the picking season commences, several strings are cut, and the beautiful trailing vine, upon which it would seem impossible to find lodgment for another bloom, is carried over a box or basket, and the picker quickly and skillfully removes the blossoms and drops them into the receptacle prepared for them. Clean picking is a rule; and if in the box leaves or tendrils or anything but just hops be found, a black mark is entered against the picker, and if the offense is repeated the picker is given his time, with the additional information that his services are no longer required.

In addition to the pickers, who are paid by the pound for their work, eighty-five additional men are employed in the gardens which I visited, for hauling hops, working in the dry kilns, in the cooler and press rooms, as weighers, and various other departments. Each afternoon the weighers go to the fields, where the hops are transferred from the pickers' baskets to the scales, and after they are carefully weighed and recorded, they are loaded into great vans and carried to the drying kilns, where a half ton per day is dried and sulphured; then to other vast buildings, where they are bleached and allowed to cool for several hours, when they are sent to the baling rooms, where they are pressed and baled. After the processes above enumerated they must be sampled and sold.

EDUCATION OF THE PHILIPPINE TRIBES.

In the Philippine census literacy was defined as ability to read and write in any language, such as English, Spanish, or a Malay dialect. The reading of Spanish was discouraged from the earliest times by the friars, who felt that it would result in a diminution of their authority. Therefore the majority of those reported as literate can read and write only in their native language. More than half of the population can neither read nor write in any language, and of the 44.5 per cent able to read less than one-half can write, while the number able to both read and write constitutes only one-fifth of the population at least 10 years of age. Only 1.5 per cent have received a superior education. Thus the condition regarding literacy closely resembles that of Porto Rico. Limited as are the educational facilities in the Philippine Islands under the best conditions, it is interesting to observe that the females have received far less advantages than the males, for while about two-thirds of the males who were taught to read were also taught to write, only one-fourth of the females received equal instruction. At the lower age periods the proportion of those who know how to read and write increases, reflecting the marked increase in educational facilities for both sexes. The increase in the proportion for girls is especially noteworthy. The number attending school, as shown by the population schedules, is 811,715. This number far exceeds the returns shown on the school schedules, probably because the calendar year does not conform to the school year. The sex proportions among those attending school are 54.6 for males and 45.4 for females. Those attending school are almost entirely persons of school age, more than half being between the ages of 10 and 14. Of the total number of children of school age 37.5 attended school.

Males of voting age form nearly one-fourth of the total Christian population, and of this number only about one-third are literate. Ninety-seven per cent of the males of voting age are of Filipino citizenship. The most literate tribe is the Pampangan, nearly half of whose males of voting age are able to read and write.

As was to be expected, the census returns show that there was a wide range in literacy among the various provinces.

THE SKINS OF FUR-SEALS.*

By Charles H. Stevenson.

There are two distinct groups of marine mammals commonly called seals. The members of one family, the *Otaridæ*, provide the fashionable fur, and are known generally as fur-seals; while the *Phocidæ* supply seal leather and oil, and are called seals or hair-seals.

The northern fur-seal pelts on the market are of three sorts, viz: Alaska skins, Copper skins or Copper Island skins, and Northwest Coast skins. Of the southern pelts the principal varieties are the Lobos, the South Shetland, the Cape Horn, and the Cape of Good Hope skins; but the present yield of these is quite small compared with that of the northern skins. These several classes of pelts are distinguishable from each other and sell at different prices. The Shetland Island skins are the choicest, but they are now very scarce and are rarely on the market. Of those obtainable in marketable quantities, the most valuable are the Alaska skins; next are the Copper skins; and the Lobos and Cape of Good Hope skins are of least value.

The pelage of the Alaskan fur-seal consists of a nearly uniform coating of dense, soft fur overtopped by coarse rigid hair of varying length. The coriaceous membrane is thin, pliable, and of light weight. The fur increases uniformly in thickness and fineness all over the body until the third or fourth year, when it is about three-eighths of an inch in length and is in its greatest perfection. After the fourth year it grows longer and thicker on the neck and shoulders and becomes thinner on the posterior parts, thus deteriorating in value. The hair overtopping the coating of fur is longest on the back of the neck, where in case of four-year-old males it reaches a length of two inches or more; on the posterior parts it is shorter, and near the hind flippers it is usually less than an inch in length; on the limbs it is much shorter and less dense, and in some places quite absent. It is shed annually in August and September, new hair appearing as the old is cast. The process occupies about six weeks, and while in that condition the skins are known as "stagy," and are of inferior value owing to the amount of labor required in the process of dressing.

The Alaskan skins have constituted the greater part of those on the market since fur-seal has been fashionable in Europe and America. The Pribilof Islands, whence they are obtained, have probably yielded one-third of the total product of fur-seals for the last two centuries, and 80 per cent of those secured in the last seventy-five years. From the reports of the United States Treasury Department, it appears that from 1870 to 1900, inclusive, 1,837,563 marketable fur-seal skins have been shipped from the Pribilof Islands, and the revenue to the United States Treasury has amounted to $7,812,036.

The fur of Copper skins, from the Commander Islands, is coarser and less dense than that of the Alaska skins, and commands a lower price in the markets, usually about 70 per cent of the price of the latter. The pelt is also less porous than that of the Alaskan skins, this being especially noticeable in the process of working them preparatory to leathering. It is far more difficult to unhair a Copper skin, as the membrane is harder and stiffer and the hair more brittle.

Since 1871 the Russian government has leased the sealing rights on the Commander Islands under conditions similar to those in the Pribilof lease. Following this, the number of skins secured averaged between 35,000 and 40,000 for upward of twenty years, but during the last six years it has greatly decreased.

The skins from Robben Island, in Okhotsk Sea, were formerly classed separately from those obtained on the Commander Islands, and were regarded as inferior, owing to the greater difficulty in removing the hair and the lighter color of the fur. Improved methods of dressing and dyeing have lessened this difference, and within the last fifteen years they have been combined with those caught on Copper Island and included in the term "Copper skins."

The Northwest skins are obtained in the North Pacific Ocean and the adjacent seas, and are the product of the so-called pelagic fishery, which has occupied so much attention in diplomatic correspondence and in the public press during the last twelve years. Previous to 1881 the output of this fishery never exceeded 10,000 skins; then it increased until 1894, when the catch was 141,143 skins, and since then it has greatly decreased, the product in 1900 being 38,923. Notwithstanding the fact that the Northwest skins are from the same herd as the Alaska skins, they are of much less value, many of them being taken out of season, when the fur is poor and the pelt stagy. As a rule they are not so well cured as the skins taken on the islands, and have many raw spots, a result of their being salted in the foul air of the ship's hold under indifferent supervision. They are readily distinguishable from the Alaskan and Copper skins by the fact that they are all pierced by bullet, buckshot, or spear, furnishing another reason for diminished value.

The Lobos Island fur-seal, at present the most numerous of all the southern members of this family, is obtained principally from Lobos Island, at the mouth of the Rio de la Plata, which is owned and controlled by the Republic of Uruguay. It is of a greenish or yellowish-brown color, with sides of a darker brown, and the fur is comparatively long. The pelt is thin, rather spongy, and easy to work. Since 1825 the right to take seals on the island has been leased under a system of regulations resembling somewhat those in force on the Pribilof and Commander Islands. The annual product is from 15,000 to 20,000. The total number of skins obtained since 1873 approximates 415,000, valued at $4,000,000, a remarkable output for an island covering less than one square mile in area. The rookeries on this island are the only ones in all the southern seas which have been protected and they are also the only ones whose output has continued undiminished to the present time.

The general color of the South Shetland or Cape Horn fur-seal, according to Mr. Henry Poland, is light gray with a silvery hue; the neck and cheeks are whitish, and the sides and belly are of a rich brown. The fur is thick and heavy, and of a reddish or deep pink color. The habitat of this seal is the islands in the Antarctic Ocean, and it is more numerous on South Shetland Island than elsewhere. When in good condition this fur is the choicest on the market, its quality being much superior to that of the Alaskan seal, the high latitude and the rigor of the climate developing the fur into full perfection at the time when the seals seek those shores. During the seventies the skins of the South Shetland fur-seals sold for nearly twice the price of Alaskan skins, although, owing to the inferior quality of the leather, they are less durable. Since 1882 the receipts of Cape Horn skins have been small and irregular, ranging from 6,000 to less than 100 a year. The high prices of the pelts have resulted in the searching of every accessible beach and rock in the southern oceans and the removal of all fur-seals that could be secured, their only protection being the severe weather, which often makes it impossible to effect a landing on the rookeries.

The total number of fur-seals marketed since their introduction in the early part of the eighteenth century aggregates probably 13,000,000, of which 5,000,000 were secured from northern localities and the remaining 8,000,000 from the rookeries of the southern seas, the great bulk of the latter being marketed at Canton, China, a hundred years ago. At the present price the total value of these pelts would approximate $500,000,000, but owing to their cheapness in the early years, when the greater part of them were obtained, the actual returns have probably not exceeded a tenth of that amount.

In curing fur-seal skins preparatory to shipment it was formerly customary to dry them while held stretched upon the ground by the use of stakes and twine or by means of wooden pegs driven through the edges. It was often impossible to dry the skins thoroughly in the damp climate of Alaska; and even when artificial drying was resorted to, it was frequently difficult to prevent them from deteriorating while *en route* to market. The drying process also made it difficult to unhair the pelt in dressing. This led, about 1855, to the salting of the skins, which is now the general practice. However, a few are dried by the natives along the mainland and on the adjacent islands of Alaska, a thousand or more being marketed each year.

FUR-SEAL MARKETS.

Previous to 1855 fur-seal skins were in little demand in Europe or America. The fur was not fashionable and the skins were made into gloves and riding rugs, caps for cabmen and street peddlers, and even for the covering of trunks and boxes. Another use to which they were put when unusually cheap in the European market was to clip the fur from the skin and tan the latter for the general purpose of leather, while the cut fur was either discarded or manufactured into napping for "beaver hats." But few hats were made of this material after the adoption of silk felt.

About 1825 the unhairing and dyeing of fur-seal was introduced, and although the article was very poor compared with the choice product of the present time, it was a decided advance over the former methods of dressing. Between 1855 and 1870, through experiments on the part of Messrs. Oppenheim & Co., and of Messrs. Martin & Tiechman, in London, and of Mr. George C. Treadwell, in Albany, the methods of dressing and dyeing fur-seal were greatly improved, resulting in an exquisitely soft and downy texture and rich dark-brown color, which was quickly adopted by the fashionable world for cloaks, jackets, muffs, trimmings, etc. So popular did the fur become that the demand quickly ran up from 10,000 skins in 1860 to 20,000 in 1865, to 150,000 during the seventies, and 200,000 during the eighties at greatly increased prices. The high prices resulted in excessive drains on the rookeries and unwise methods of slaughter at sea, so that the quantity of skins obtainable now is very much less than ten or fifteen years ago, only 95,485 being handled in 1900, and the price is much in excess of what it ever was before.

Previous to 1871 fur-seal pelts were comparatively cheap, the undressed Alaskan skin rarely selling for more than $4 or $5; but since that time the market price has greatly increased. In 1875 Alaskan skins averaged about $13 each; in 1880, $20; in 1885, owing to the large number received from the pelagic fishery, the price fell to about $16 each, but in 1890 it increased to $35, and in 1900 to $40.

Since 1870 practically the entire world's product of fur-seal skins has been sold in London. Most of them are handled by Messrs. C. M. Lampson & Co., who receive consignments from the North American Commercial Company, the lessees of the right to take skins on the Pribilof Islands; from the Russian Sealskin Company, the lessees from the Russian government of the rights on Commander Island and Robben Reef, and a large portion of the Northwest skins. Other

* Extracted from U. S. Fish Commission Report for 1902.

prominent firms in London handling skins are the Hudson's Bay Company, Messrs. Boulcher, Mortimer & Co., the consignees for Lobos skins, and Messrs. Culverwell & Brooks, who receive many of the Northwest skins.

The skins are duly catalogued, and public-auction sales are held at stated times during the year, usually in March, October, and December, when all the leading furriers of Europe and America are represented, the number averaging about 50. Generally the entire stock on hand is sold at each occasion.

The consignments of skins are assorted according to the size, the following grades being recognized:

Name of class.	Age.
Wigs	6 to 10 years.
Middlings	4 to 5 years
Middlings and smalls	
Smalls	4 years.
Large pups	3 years.
Middling pups	2 years.
Small pups	
Extra small pups	1 year.
Extra extra small pups	Under 1 year
Gray pups	

The following summary, compiled by Mr. Alfred Fraser, shows the total number of skins offered at the London auction sales during each year since 1872:

STATEMENT OF THE NUMBER OF EACH VARIETY OF FUR-SEAL SKINS OFFERED IN LONDON DURING A SERIES OF YEARS ENDING IN 1900.

Year.	Alaskan.	Copper Island.	Northwest coast.	Lobos Island.	Cape Horn.	Total.
1872	96,283	7,182	16,312	7,000	320	127,097
1873	101,248	21,614	931	6,956	9,000	139,749
1874	90,150	30,349	8,843	8,509	8,600	146,451
1875	99,634	34,479	3,575	8,179	9,500	155,369
1876	99,267	83,298	4,097	11,353	6,306	145,321
1877	75,410	25,380	1,945	13,066	7,631	123,432
1878	99,911	19,000	3,610	12,301	8,227	143,046
1879	100,036	28,211	15,527	12,295	12,180	168,249
1880	100,161	38,885	13,501	14,836	17,562	184,945
1881	99,921	45,209	16,573	13,569	13,164	188,436
1882	100,100	39,111	23,765	13,200	11,711	187,329
1883	75,914	36,500	5,028	12,861	4,655	139,474
1884	99,887	26,675	19,269	16,258	6,743	169,705
1885	99 719	48,929	20,265	10,953	3,404	183,270
1886	99,910	41,752	33,973	13,667	909	190,213
1887	99,940	54,584	43,339	11,068	2,762	211,693
1888	100,000	46,333	40,000	20,749	4,403	211,483
1889	100,000	47,416	41,808	8,755	3,021	201,000
1890	20,994	95,486	39,014	18,541	2,450	176,485
1891	13,473	17,025	55,263	15,834	3,114	104,709
1892	7,554	30,678	64,108	12,202	6,292	120,834
1893	7,492	32,832	121,618	13,624	2,131	177,697
1894	16,030	27,298	171,914	12,145	62	227,449
1895	15,002	17,721	57,842	12,017	1,888	104,470
1896	7,500	14,415	30,651	14,019	2,510	99,095
1897	22,504	(a)	68,623	13,407	2,037	106,571
1898	20,762	13,726	46,178	30,348	3,900	114,914
1899	26,434	8,942	44,998	15,381	6,291	102,041
1900	19,935	9,784	42,829	15,116	7,821	95,485

a The 1896 skins were sold in December, 1896; no 1897 skins were sold until March, 1898.

Previous to 1820 no market existed for fur-seal skins in the United States, and practically all of those received from the Southern oceans were reshipped to China, either direct or by way of Europe. In 1822 Mr. Denison Williams, a cap manufacturer of Albany, N. Y., introduced fur-seal caps to the trade. From a manuscript written by him, and now in the possession of Mr. Samuel Williams, we have extracted the following notes in regard to the development of this business:

"In 1822 the first fur-seal came into our market. At that time no one knew a process of removing the hair from the fur, therefore we made them into caps with the hair on, which took well. The next season we used large quantities of fur-seal, and after a number of experiments succeeded in removing the hair, greatly increasing the value of the fur. Those skins were from the South Shetlands, then just discovered, and were the finest ever found. The next season we prepared a lot of hair-seal caps which took well in the Southern markets. In the fall of the following season (1825) we succeeded in coloring both the fur-seal and the hair-seal skins, the first ever colored in this country, thus enhancing their value 100 per cent."

Mr. Williams was quite successful in the fur-seal cap business, establishing agencies in Boston, New Orleans, and Nova Scotia, and having made a net profit of $60,000 in four years, retired in 1827. The business was continued by Mr. Williams's former associates, Messrs. Packer, Prentice & Co., who built up a large trade, their manufacture of various furs in 1831 amounting in value to half a million dollars. In 1833 Mr. George C. Treadwell, who in later years enjoyed so prominent a reputation in fur-seal dyeing, began dressing the skins, and in a few years others embarked in the business, making Albany the principal center in the United States for this industry. Fur-seal skins constituted a large item in the business, 20,000 being unhaired and dyed in a single year, nearly all of which were used in the manufacture of caps. Previous to 1835, most of the skins were dyed "London brown." In that year Mr. James Chase, of the Treadwell company, discovered how to give them a dark plum color, and afterward deepened it to a deep sable hue.

The skins were obtained from the South Shetlands and other places in the vicinity of Cape Horn and from various places on the west coast of Africa. With the decrease in yield from these localities about 1840, the business at Albany began to wane, and finally fur-seal skins became so scarce that nearly every manufacturer ceased using them. Mr. Treadwell continued their use for caps and gloves, obtaining his supply of raw skins from the occasional lots received from the southern seas, supplemented by shipments of Pribilof skins from London.

The attention of Mr. Treadwell having been called to the growing demand in London for fur-seal sacques, he began dressing and dyeing the skins for the trade in the United States. He did not produce the seal-black fashionable at the present time, but a reddish brown, which became known as seal-brown. This product gave excellent satisfaction, the dye retaining its bright color without fading. Meeting with sufficient demand for his output, he did not attempt to secure the black shade of color finally adopted by the London dyers in response to the demands of fashion.

Mr. Treadwell was the only fur-seal dresser in this country up to the year 1878, when Mr. J. D. Williams, of Brooklyn, the son of Mr. Denison Williams, referred to above, began dressing and dyeing the skins a dark brown, similar to the London color. At the present time, the sons of the late Mr. J. D. Williams, above noted, are the only fur-seal dressers and dyers in this country, although there are many who redye skins. The reason fur-seal skins are not dressed and dyed more extensively in the United States is not due to the high cost of labor here, for that is more than counterbalanced by the 20 per cent import duty on the prepared skins; nor is it due to the lack of expert workmen. The principal reason is that the raw skins are sold in London and harmonious co-operation exists among the fur brokers, fur dressers, and bankers there, so that a first payment may be made on skins purchased in the fall, and most of the purchase money be withheld until the skins have been dressed, dyed, and made ready for manufacture six or eight months later.

In estimating the industrial value of the manufacture of fur-seal articles in the United States, seven of the principal furriers made affidavit in 1892, as follows:

"The number of Alaska fur-seal skins that are imported annually into the United States, after dressing and dyeing in London, is, upon the basis of the importations during the past ten years and upon a catch of 100,000 skins at the Pribilof Islands, correctly estimated at 65,000 to 75,000. The value, before paying duty thereon to the United States, of each dressed and dyed fur-seal skin so imported, may be said to range between $15 and $50, with an average value during the past ten years of about $25 per skin. The wages paid annually to people engaged in the manufacture and remodeling of seal-skin articles are, on an average, about $7 a skin, or upon 70,000 skins, $490,000. The profits made annually by merchants, wholesale furriers, and retail furriers amount to about $30 a skin, or upon 70,000 skins $2,100,000. The amount of silk consumed annually in the manufacture in the United States of 70,000 fur-seal skins into articles and in the repairing of these articles may be estimated at $150,000 to $200,000. All silk which is being so consumed at the present time is made in the United States. Working men and women are employed in the industry of manufacturing seal-skin articles in the United States as follows:

Classification.	Number.	Wages per diem.	
Fur-cutters (i. e., people who trim, repair and prepare the general shape of skins)	1,200	$3.50 to	$4.50
Nailers (i. e., people who stretch and nail skins into shape on boards)	600	2.00	2.50
Sewers and finishers (i. e., people who put the article into final shape	1,500	1.50	2.00
Those who machine skins (i. e., remove the portion of guard hairs left by the unhairers)	60		2.00
Total	3,360		

"The fur-cutters represent skilled labor of a high order. No account is taken of porters, clerks, salesmen, etc., employed in the large establishments."*

Owing to the smaller quantity of skins received on the market at the present time, the number of persons employed in manufacturing them into garments is much less than in 1892, probably not over 60 per cent as many. The total number of persons actively employed at present in various parts of the world in handling fur-seal skins from the live animals to the finished garments probably aggregates 4,000, and the total value of the product $6,000,000 or $8,000,000 annually.

METHODS OF DRESSING AND DYEING.

The present method of dressing fur-seal skins represents the highest development in the fur-dresser's art. The difference in appearance between a raw and a finished pelt of beaver, otter, or muskrat is comparatively small; but the raw fur-seal skins, as received at the fur dresser's establishment in their dirty and unsightly condition, bear little resemblance to the finished product delivered to the garment manufacturers. The following account of the present methods of dressing these skins is based on information furnished by fur-dressers of New York and London, and especially by Mr. Samuel Williams and Mr. Max Bowsky, of New York city:

The moist skins are first freed of salt and then "blubbered," consisting in placing each skin, fur down, on an inclined wooden beam somewhat like a tanner's beam, and with a two-handled knife removing all particles of blubber, flesh, and other extraneous matter, care being taken that no cuts or uneven places are made in the pelt. These blubber scrapings are oleaginous and are usually handled by manufacturers of oils and greases. The skins are soaked in cold water over night and then washed in strong soap water, the amount of washing depending on the condition of the pelt, some pelts standing more than others, too much washing loosening the fur. Whale oil soap was formerly considered necessary for this, but its use is now almost abandoned. After the washing, the skins are placed on a beam with the fur side up and the grease and water removed by scraping or pressing with a beaming knife.

Then comes the depilation or unhairing, the most difficult and important single step in the process. In preparing for this, a slight difference of practice exists among the various dressers. Usually after the washing, as above noted, each skin is stretched and sewed with heavy cord to the rim of an iron hoop and suspended in dry atmosphere until thoroughly dry, usually requiring several days. Next they are soaked in cold water from one to three days, the length of time varying according to the condition of the skin and the temperature of the water. On removal the fur is dried and the skin made quite warm, doubled together, and sweated in a warm place from one to three hours or until the hair commences to start. In some establishments the drying of the skins on iron hoops is omitted entirely, and the fur is dried and the moist pelt warmed and sweated as above noted immediately after the washing process.

When the skins are in good working condition, the picker or unhairer bends several of them across boards by the side of a stove, and thus warms and dries the fur side, keeping the skin side moist in the meantime. Each skin while warm is successively placed on the unhairer's beam, pelt side down, and the hair removed by using a dull knife of soft metal, known as a picker's knife, the workman grasping the hair between the knife and his thumb, the latter being protected by a rubber cot. Extra force should not be used in case the hairs do not yield readily, for they are liable to break off; but the pelt should be again moistened and the fur side warmed. After a portion of the skin has been unhaired, it is necessary to warm another part of it at the stove, keeping the pelt moist as before, and the operation is continued until the entire skin has been unhaired. In order that the hairs may be easily removed, it is necessary to heat the skin to the limit which it will stand without injury, and much experience is required to determine this limit. Many skins have been so injured in the unhairing that the fur loosens and readily comes out after a few weeks' wear.

For economy of time, a workman generally operates on three or four skins at the same time, unhairing one while the others are warming. The hairs must be pulled out and not broken off. Care is also taken to avoid removing the fur with the overhairs, and thus leaving bare spots on the pelt. Even after the above process stagy skins retain many short or second-growth hairs which reach a short distance above the fur. Many of these may be removed by the picker warming the skin and passing a dull beaming-knife rapidly over the fur. When the skins are very stagy they are sometimes unhaired in part from the skin side. The roots of the hair penetrate the membrane farther than those of the fur, and when the skin is pared down thin the hairs may be pulled out by grasping the base of the roots.

The skins are next stretched and nailed on boards and dried very hard, the drying continuing from two to five days to remove every particle of moisture. On removal they present the appearance of thin, uneven boards with little curls of brown fur on one side; these may be cracked or split by a person walking on them almost as readily as though of wood.

When opportunity presents, the dried skins are dampened on the pelt side with fresh or salt water and skived or shaved on a beam with a currier's knife to a thin, even surface. Salt is used in the water to prevent the fur from coming loose, but too much salt "cuts" the leather, and its use is not desirable except in hot weather. Some dressers postpone this shaving until after the fur has been dyed, but others are so annoyed by the grease coming out of the thick membrane and interfering with the dyeing of the fur that they thin the pelt at this stage of the process. The pelts are stretched and partly dried, being "worked" in the meantime to prevent their drying stiff and hard.

The pelt side is then covered with butter or other animal grease, and the skins are softened or leathered by tramping them in tubs, with a quantity of fine or veneer hard-wood sawdust, or in a tramping machine built on the principle of a fulling mill. This leathering is afterward continued until the grease is driven thoroughly into the pelt, requiring from two to four hours in either the tramping tub or the fulling machine. The skins are then cleaned free of grease by revolving them with a quantity of fine sawdust, and this is in turn removed in the beating drum, thus terminating the operation of dressing.

Next comes the dyeing process. All holes and defective spots are first mended. If the pelts have been already partly shaved, a sheet of paper is pasted on the flesh side; but if the pelt has been left thick, as is commonly the case, the paper pasting is omitted. The fur is treated with an alkali solution, followed by an acid mordant, for the purpose of "killing" the surface. Each establishment has its own formula for making the dye, the secret of which is usually carefully guarded. Formerly the fur was frequently bleached to a golden hue by means of chloride of calcium or peroxide of hydrogen, or, as was the usual practice in the United States, by a brushing of aqua fortis, over which

* Fur-seal Arbitration, Washington, 1895, Vol. III. p. 536.

hot irons were immediately passed; but this color is no longer fashionable. In most establishments the dye for the ends of the fur consist of various combinations of copperas, alum, salt, litharge, antimony, copper dust, verdigris, red tartar or argol, and salmiac. The ground color is formed of combinations of logwood, hippuric, fustic, nutgall, and iron liquor, in varying proportions, according to the experience and fancies of the dyer.

The fur is prepared for coloring by the application of a lime solution. Then the surface coloring is applied with a large brush, the points of the fur being carefully covered to the required depth. After lying folded, with the points touching each other for 6 to 12 hours, the skins are hung up and dried. When dry this dye forms a thin layer or crust, which is broken and beaten out with rattan sticks. Other coats of dye are then successively applied, dried, and the crust removed until the desired effect is secured. For the light brown shade formerly popular, 18 or 20 coats of the dye were necessary; but for the very dark shade popular at present fewer coats of a much stronger dye are used, the usual number applied being 8 or 10. Some years ago a process of dyeing was introduced by which the fur was dipped into the dye, which in this case must be hot. Fewer coats were necessary and a more brilliant color was imparted, but the texture of the fur was injured to some extent by the hot liquid.

When the desired shade is reached for the top of the fur, four or five coats of the more delicate dye are successively brushed on heavily and tramped in, forming a base or ground color. In tramping this ground color in, two pelts are placed together on the floor with the fur sides against each other, and the dyer lightly treads on them for two or three minutes. The skins are thoroughly cleaned with sawdust and all superfluous dye removed. The pelt is then moistened with water and shaved down to the required thinness, removing all superfluous flesh and leather and leaving the pelt clean and free from dye. The skins are revolved in a cleaning drum, with maple or other light-colored veneer sawdust for several hours, and on removal, and after beating free of sawdust, are ready for manufacture into garments.

While the foregoing is the general process, it is necessary to vary it for different skins, and successful dressing and dyeing require long experience and much judgment. Owing to the necessity for drying the skin a number of times in the dressing, and also after the application of each coat of dye, the length of time required for both operations is six to eight weeks. The expense of this work in London is about 14 shillings, while in New York, owing to the higher price for labor and materials, it is about $5 for each skin.

No matter how carefully the unhairing process is performed, a number of hairs are broken off near the surface of the fur, and there remain many of young growth and not yet above the surface, detracting from the beauty and softness of the fur, but adding thickness and durability, owing to the protection afforded. In the early history of fur-dressing in England and America these few hairs were left in, but when fur-seal increased in fashion it became important to have the fur as free from coarse hairs as possible. From 1870 to about 1882 the few hairs remaining after the process of depilation were removed commonly by hand labor, a slow and expensive process. Most fur manufacturers employed girls to "pick" the skins. Blowing open the soft fur with her breath, the operator cut off the stiff, extended hairs with small shears, requiring one to five days for one person to complete a single skin.

Since 1883 most of this work has been done by complicated mechanism which accomplishes the work as effectually and far more expeditiously. In this process the skin is bent across the upper edge of a vertical board and the soft fur blown aside and divided by a thin, wide current of air from a bellows, when a pair of small knives descend and cut off the stiff, upright hairs. The knives are raised, the skin advanced the fraction of an inch, and the operation repeated until the entire surface is gone over, requiring about one hour to complete an average skin. This removal of the short hairs is invariably postponed until after the dressing and dyeing are completed.

On the adoption of fur-seal as a fashionable material, about 1870, and the great increase in price which quickly ensued, many substitutes were introduced, and since then few furs have been so frequently imitated. These were prepared from numerous cheaper furs, as otter, beaver, nutria, muskrat, cony, and even sheep. The otter, beaver, and muskrat imitations were fairly successful, especially for the manufacture of caps, gloves, and trimmings. They were not satisfactory for cloaks, the membrane being too thick and too weak to trim down sufficiently thin. The garments looked well at first, but soon showed wear, especially at the seams, and the dye faded. A large market was developed on the continent of Europe, especially in Germany and Russia, for fur-seal imitation prepared from muskrat pelts, this cheap substitute greatly injuring the market for the genuine material. Owing to the general dissatisfaction resulting from their use, these imitations were gradually abandoned by reliable furriers, and with the exception of that made from the French cony or rabbit, and known as "electric seal," "coast seal," "China seal," "Canadian seal," etc., fur-seal is not frequently imitated at the present time, except for trimmings and small articles.

The power going to waste at the Victoria Falls on the Zambesi River, in South Africa, is calculated at 25,000,000 horse-power, or five times that of Niagara.

SIMILARITY OF GREEK AND NIPPUR POTTERY.*

By Clarence S. Fisher.

No pottery or other small objects that would enable us to date exactly have come from the palace of Nippur itself. Let us, therefore, turn at once to a review of some of the objects from the other parts of the site.

Fig. 1.—A PAIR OF LOVERS. TERRA-COTTA FROM NIPPUR. LATE GREEK PERIOD.

Height, 5.25 inches.

Among the many, space allows but a few to be illustrated. There are figurines of men and women in Greek costume; warriors; musicians; a stele depicting Orpheus playing upon his lyre and attracting round him a group of various animals with all their limbs admirably drawn; steles of religious scenes belonging to the peculiar Mycenaean worship; and a host of others covering nearly every occupation.

Some of these belong to the last Greek period of occupation at Nippur, during the ten years following the conquest by Alexander in 330 B. C., but the difference in type readily distinguishes these from the older ones. These examples of the later period will be given first.†

Fig. 1 is an exquisitely modeled little group of lovers in terra-cotta. The surface is worn smooth in several places and portions of the lower limbs are broken away, but the graceful folds of the drapery and the well-modeled anatomy showing through it are well preserved. It is one of the best examples of the later pure Greek period at Nippur.

The most noticeable thing in all Babylonian work is the symbolism embodied in some way in every piece of sculpture or plastic work. Figures of Bel and Beltis predominate. Bel, with his symbols of overlordship clasped tightly in his hands, and Beltis, emblematic of life and reproduction, holding a child in her arms and sometimes nursing it, are found everywhere. In these the sexual parts are always strongly emphasized, the lower part of the abdomen being usually made in the shape of a triangle and deeply marked (Fig. 2). But there is never any attempt to infuse life into the pose of the figure. Now we find just such figurines occurring at Tiryns and other Mycenaean points, showing all the characteristics of this crude Babylonian art and lacking in the idealism later infused by the Greeks

Fig. 2.—CHARACTERISTIC FIGURE OF BELTIS

Height, 4.70 inches.

into their work; and we can at once accept this as a proof of a close relationship between the two countries, and an interchange or commingling of their workmanship at a time when each country was making and holding to its own ideals. The crude Babylonian type never left a permanent imprint on the soil of Greece, but, on the contrary, we find that the influences planted at Nippur and at other sites, as the further investigation in Babylonia will show, held their own for a considerable period after their originators had been swept away, and now and again down through the succeeding *régimes* we find them cropping out. All the latter work is merely a copying of such Greek work as remained to them.

We now come to some examples of the older Greek

Fig. 3.—HEAD OF MYCENAEAN WARRIOR IN STONE. FROM NIPPUR.

period. The objects of this series were found, as were the others, scattered all over the mounds at a depth much below the later Greek work, and belonging to the same level as the palace. One of the most interesting examples is shown in Fig. 3. It is in stone and apparently belongs to an entire figure of which the rest has unfortunately not been found. The headband, the wave-scroll ornament on the cap, and the beard are characteristic of Mycenaean work. From a

Fig. 4.—GOLD FACE-MASK FROM NIPPUR.

burial of this period comes the gold face-mask identical with those discovered at Mycenae (Fig. 4). Perhaps the most remarkable object found is that in Fig. 5. Here is the exact representation of the Mycenaean Tree and Pillar cult on a small terra-cotta stele. Fig. 5 is a photograph from a cast now in our Museum at Philadelphia, the original being kept at Constantinople. We cannot for an instant suppose that these

Fig. 5.—SACRED TREE AND WILD GOATS. TERRA-COTTA STELE FROM NIPPUR.

Size, 3.50 inches by 2.95 inches.

objects, which are but selections from a great number of similar finds, are accidental, or are perhaps objects imported as curios from Greece into Babylonia. They are found, not in any one isolated spot, but in private houses, in graves, in public places, showing that they were in common use and held in some considerable degree of estimation by the inhabitants, who would not have made use of them unless they were familiar with them and understood their value and real significance.

* Abstracted from the American Journal of Archeology.

† My object in introducing here a description of the objects belonging to the later Greek period is not only to show their marked difference from the Babylonian type, but more especially to contrast them with the objects of the first Greek or Mycenaean period described farther on. These latter, while not found in the palace itself, definitely establish the existence at Nippur of a Mycenaean stratum. Since the palace displays the same characteristic influence architecturally as do these objects artistically, we can consider them together.

MUSICAL INSTRUMENTS: THEIR CONSTRUCTION AND CAPABILITIES.—I.*

By A. J. Hipkins, F.S.A.

The inquirer about musical instruments, who turns for information to established works upon instrumentation, will find his curiosity about their construction and development unappeased, as the musician's point of view is directed solely to the use he can make of them. If he turns to musical dictionaries or technical works, he will still remain unsatisfied, because the information is, for the greater part, supplied in a fragmentary form. The intention of these lectures is to explain the construction and capabilities of musical instruments from a more general aspect—briefly, it must be, as in three lectures there is not time for a detailed study. I can only sketch the outlines of a work.

I will begin with the various stringed instruments—whether they are touched, twanged, or bowed to produce their sounds—that have been used in modern European music; continuing with the various wind instruments, wood or brass, whether blown by the lips, by means of a single or double reed, by a whistle or a mouthpiece; also the drums and other percussion instruments; and, lastly, gathered for the sake of convenience into a separate class, the instruments played with an intermediary keyboard, borrowing from the wind the organ and harmonium, and from the stringed division the piano.

Of the stringed instruments, the violins are the first in importance, whether it is for power and delicacy of musical expression, fitness for exact intonation, or arriving at structural perfection almost at once, since no change has taken place in the violin from its invention 350 years ago; and apart from its musical value, a well made violin is in form, and often in color, a never-tiring enjoyment to the eye. It is the sum of these fine qualities that justifies the pre-eminence always accorded to the violin family. But in praising the instrument the bow must not be overlooked, as it is indispensable for the production of the tone, and is the means by which the player can impart his personal musical feeling, and take a part in reproducing the masterpieces of the modern masters of chamber music and the orchestra. Unlike the violin, which has changed so little, the bow was improved by degrees until about 100 years ago, when it was fixed and made perfect by the beautiful contrivance of Tourte.

The invention of the violin is attributed to Gasparo da Salo, of Brescia, about the year 1550. There is no certain evidence about the instrument it may be supposed preceded it, and was also tuned, like the violin, in fifths. It may have been a German instrument altered by Italian taste. Attribution to Gasparo da Salo lacks positive evidence, but it seems to be warranted by his place in the order of time. Almost immediately after we find Maggini, the greatest of the Brescian school of violin makers, and Andrea Amati, of Cremona, the latter supplying the French King, Charles IX., with violins in 1572. Amati founded the school of Cremonese violin making, which has been universally accepted as pre-eminent. It culminated in the supreme achievements of Stradivari and Guarnieri del Gesu, in the early years of the eighteenth century.

The size and proportions of a violin are exactly calculated for a player's arm and convenience, and the lightness of the instrument (for a fine violin weighs, when fitted and strung, only from three-quarters of a pound to a pound) is as remarkable as the expressive character and the energy of the tone produced. In the best patterns, excluding the neck, it is not more than 14 inches long, and at the widest part it hardly exceeds 8 inches. The strain of the four strings in the present day depends, of course, upon the thickness and corresponding weight of the stringing. With a heavy stringing it has been given by Mr. George Hart as 62¾ pounds, and with a light stringing 52½ pounds, the downward pressure upon the bridge being 27 pounds 13¼ ounces and 23 pounds 5 ounces, respectively, at the modern Philharmonic or English orchestral pitch of 452.5 double vibrations per second, for A, the open note of the second string. But I am not sure that Mr. Hart took into consideration the height of the bridge, which adds to the tension more or less. The first string is tuned a fifth above this A, and bears the greatest strain; hence its penetrating tone quality and also its liability to break. The third string, which should be the most mellow and full in tone quality of the instrument, is tuned a fifth below the second. All these three strings are of gut, and selected from the small intestines of sheep, prepared by a long and very careful process to separate them into threads. Three or four of these threads are spun for the first and second strings and six or seven for the third. The fourth string in a violin is a covered string, that is to say, it is of gut spun over with fine silver or copper wire; the loading of the string is to increase the thickness and weight, so as to make the rate of vibration slower. The accordance is thus: G below middle C, D, and A in the octave above it, and E above C in the treble clef. The strings being all of the same length, have to be made gradually heavier in the order of second, third, and fourth to obtain this accordance. Although these strings are less strained than the first, the making up by thickness is essential, as well for the fullness of tone as for the tension required. It will therefore be seen that, owing to these conditions of uniformity of length and the difference of thickness and tension, the violin, with all its merits, is far from being a perfect instrument, as may be heard when a player has the misfortune to break the first string, and continues with the second for his highest string.

We will now regard the bridge, belly, and back, the sound post, and brass bar. The violin is a resonant box built entirely of wood, no metal of any kind properly entering into its structure. The back is of a hard wood, frequently maple, and is usually in two pieces, joined down the middle, but may be in one piece. The belly is of a soft wood, spruce fir (*Abies excelsa*), chosen with a fine regular grain suitable for uninterrupted vibration, and dried by long exposure to the air. This is also usually in two pieces, although it may also be of one. Spruce (when cut commonly known as deal) is the best resounding wood, on account of its slight density and uniform elasticity. The function of the belly is to re-enforce the sound initiated by the strings, in accordance with the law by which all substances capable of a certain rate of vibration will respond to that rate sympathetically whenever submitted to its influence, the distance not being too great for communication. The strings, which, from the way they are agitated, vibrate transversely, or across, when in motion, offer too little surface to affect the surrounding air to become more than very feebly audible. But their vibrations, carried through the bridge to a much wider superficial expanse of wood which is called the belly, are largely increased or re-enforced, as is well known of all stringed instruments furnished with sounding or resonance boards. Wood, and particularly firwood, is a very much better sound conductor than atmospheric air. To illustrate the power of resonance, it will be sufficient to compare a practising or dumb violin that is sometimes made without resonance box, and a real one. The wood takes up the sound of the strings with all their proper tones, to the very smallest vibratory movement, as well as the most complete harmonic combination, exactly the same as the atmospheric air, and no more. Thus all vibrations and figures, however complicated, initiated by the friction of the bow upon the strings, are transmitted to us from the wooden box, and completely, if not impeded or quenched by any imperfection in the wood, through the ever-faithful environing air. Suppression of the original force imparted by the player, from the exhaustion of energy and the all-compelling power of gravitation, is nearly instantaneous, a sustained tone being only maintained by the bow.

The back and belly of a violin are connected by six strips of maple, technically called ribs or sides, which complete the framing of the resonance box. They help to transmit the vibrations of the belly to the back, and are attached by means of glue. The curvature of the sides was early introduced in a precursor of the violin, to enable the bow to pass easily across the strings. It divides the shape of the instrument into what are technically called the upper, middle, and lower bouts. Both back and belly are vaulted more or less in opposite directions, according to curves which have been empirically determined by the influence this vaulting has upon the tone. It also offers a certain mechanical resistance to the strain and pressure of the strings. But the building up is materially as-

1. **Alto viol with six strings and pegs, made in France, eighteenth century.**

2. Baryton. Viola di Bordone. This is a deep flat model, with sides sloping sharply from the neck to the upper blocks. Across the sound-board there is placed diagonally a strong wooden bar bearing 10 pins and 10 small hooks, forming bridges. To this bar are attached 20 thin metal strings, which pass underneath the broad neck, and are attached, 10 of them, to small iron buttons, and 10 to long iron pins placed in the side underneath the long, flat head. These 20 sympathetic strings are tuned alternately by the pins in the upper peg-box and the pins in the cross-bar. On a broad bridge, attached to the tail-piece which fits upon an iron projection at the bottom of the instrument, are 7 gut and overspun melody strings, which, passing over an ebony finger-board, are tuned by 7 pegs, placed on the right-hand side of the head, which is without scroll but decorated with a small rose. The instrument, which has seen much wear, is strengthened with ornamental and engraved plates of iron. Austria, eighteenth century. On the iron plate at the back, immediately above the neck, is engraved "J. J. S(tadlmann), 1779." J. J. Stadlmann made a baryton for Prince Esterhazy, the patron of Haydn, who wrote for this instrument a large number of solos.

3. Pochette D'Amour. Shallow box with sloping shoulders. The back and front edged with ebony and ivory inlay. Flaming sound-holes. Long peg-box, with 9 pegs, decorated in black and white ivory inlay on either side, and terminating in a blindfolded head. Five melody strings and four sympathetic strings, tuned by the higher pegs. France, eighteenth century.

4. Mandora, made in Italy, eighteenth century.

5. Lyre guitar, in which eight pegs inserted from behind had originally 4 pairs of strings of wire passing over a movable bridge and attached to ivory buttons at the bottom of the instrument. The instrument was in great favor toward the end of the eighteenth century.

6 and 7. Guitars.

8 and 9. Lutes.

10. Theorbo made in Italy, eighteenth century. The instrument has two peg boxes, the first containing 8, the second 6 pegs. An ebony bridge attached to the sound board carries 14 strings, 8 of which pass over the finger-board and 6 open strings to the upper peg-box.

11. Harp Lute. A lute-shaped body of wood, with 2 narrow sound-holes at the back. The sound-board has a single round sound-hole. Attached to a bridge fixed to the front are 12 strings, 7 of them running over the short neck, provided with frets, the rest attached to the upper part of the instrument, which resembles the curve of a harp and which is supported by a small carved pillar resting on the body of the instrument. Three pairs of finger-pieces are placed over the lower strings, and when turned produce the semi-tones. A lever at the back of the instrument drew down the sixth string upon the finger-board by a small hook (now missing), similar to that used by Hochbrücker. A second lever at the back, acting on the 8th and 9th strings, raises their pitch a semi-tone. England, c. 1800. Maker, Light, London.

MUSICAL INSTRUMENTS: THEIR CONSTRUCTION AND CAPABILITIES.—I.

* The illustrations of these articles depict instruments in the admirable collection of Mrs. Crosby Brown in the Metropolitan Museum of Art, New York city.

sured by the blocks—six small pieces of spruce, or it may be of lime or willow, shaped and glued into the instrument: four at the four pointed corners of the C's, or middle bouts, one at the top, and one at the bottom. They are set perpendicularly as regards the grain. There are also twelve strips of spruce, lime, or willow, called side linings, which connect the blocks together, and bind the resonance case into a homogeneous structure. The dark lines round the edges of the back and belly, apparently ornamental, are called purflings, and are inlaid in 24, sometimes 36 pieces. The *f f*, or sound holes, are very noticeable features in a violin. Their shape is due to the vaulting of the belly, and, like the vaulting, varies with the intention or fancy of the maker. They are characteristic of the violin family from its origin. They are cut symmetrically, on either side of the bridge, and their first intention appears to have been to give readiness of response—technically, speech—to the belly. They weaken it, to a certain extent, as the pressure of the bridge comes between them; but that loss is made up by the resistance of the sound post and bass bar. It is also a feature of the sound holes that vibrating air contained within the resonance box escapes through them. This air is set in vibration by the wood which incloses it, but has a shape or form or vibration determined by that of the instrument. If the sound holes are too large, the pitch of this air rises, and the tone of the instrument becomes shrill; if too small, the pitch flattens, and the tone becomes dull. So the shape, size, and position of the sound holes are clearly no more arbitrary than anything else in a violin. By a happy disposition the proper note of a violin, as a resonance box, behaves as a general re-enforcer, helping any note that happens to be played. The late Dr. A. J. Ellis and I made several trials of good violins by means of tuning forks of various verified pitches, in each instance proving this curious fact. The maximum of air re-enforcement was found to be about C in the treble clef, at a medium pitch, reckoned at 528 double vibrations per second, an approximate mean between the Paris normal and the London Philharmonic or Kneller Hall pitches (C 517.3, C 538). The bridge is of maple, with horizontal grain and of medium hardness, and should be about half as thick at the top as at the feet. Its peculiar design, apparently arbitrary and proceeding from the workman's taste, is really an empiric cutting presumed to have been fixed in its present form by the great Stradivari, and to depart from it ever so little in any direction is found to be prejudicial to the tone. Bridges have come down, however, of the Amatis, which are nearly of the same form. The adjustment of the bridge, as indeed every part in a violin, is of the greatest importance. If it is too thick, the tone becomes dull and difficult to produce; and if too thin, the tone becomes shrill and disagreeable. It must be remembered that the higher the bridge the greater is the tension, and that the height has to bear a certain relation to the thickness of the belly, all very nice points that only the greatest skill can deal with successfully. The feet of the bridge have to fit the vaulting of the belly. The top is rounded to prevent the bow touching more than one string. It would seem that the bridge being cut out across the belly, and resting upon the feet, is due to the center line along the belly where the wood joins, or even if it is in one piece, being a node—that is to say, a line of no vibration, but at the same time a line of maximum of molecular condensations or rarefaction, from which vibrations start. It is therefore of importance that this node may not be weighted or coerced. The experiments of Savart have proved the necessity of the cutting. The right foot of the bridge being nearly over the sound post, is itself in a nodal position, and the vibrations passing through it have been proved by the ingenious experiments of Dr. Huggins, at least in part, to be transmitted to the back. Were the violin a *pizzicato* instrument like the guitar or mandolin, no sound post would be required, but as it is a *sostenuto* one, the continued incitement from the bow has to be carried on between the belly and back, and the sound post does this, from which office the French and Italians call the sound post the soul and the Germans the voice of the instrument. It is a little round stick of spruce, a quarter of an inch in diameter, and is adjusted to firmly touch at about one-sixteenth to three-sixteenths of an inch behind the right foot of the bridge. It does not absolutely support the belly, because it might then arrest vibration, but it is practically made to fit. A violin should be strong enough in itself to bear the strain of tension. As the sound post has to be introduced through the right-hand hole, only a skilled hand, with experience to determine its exact size and position, can fit it. The bass bar is the other great tone regulator of the violin; it governs the elasticity of the belly, and increases it by the formation of a greater number of nodes or centers of no vibration, thus affecting both quality and carrying power. It is also of spruce, and is about $10\frac{1}{2}$ inches long and two-sixteenths in diameter, and should extend along the belly, to which it is glued on the under side, in an oblique direction, but the deviation inward very slight. The glued edge has to follow the longitudinal vaulting of the belly. Its depth is about three-eighths of an inch where it is deepest. If too long or too large, it will make the tone dull. The original bars of the old Italian makers are found to be too weak for the increased tension of the present day, and this is due to the thicker strings, the higher pitch, the higher bridge, and longer neck. The pitch usual in the time of Stradivari and Guarnieri was at least a diatonic semitone lower than the present English Philharmonic or Kneller Hall pitch; that is to say a quarter of a tone lower than the Paris Diapason Normal. But in the 17th century the chamber or secular music pitch, from indications in the vocal music of the time, and as we learn from Prætorius, who published his book in 1618, was about a tone and a half sharper than the very low pitch which followed it. So that the pitch Stradivari constructed his instruments for differed from that which was incumbent upon the Amatis, and probably upon himself in his early days. When we consider such important changes as the altered pitch and the ageing of the wood, combined with the difference of the bow and style of playing, it becomes impossible to recall the impression made by the tone of the Cremona violins, when new, upon contemporary ears.

The neck and head are cut from a block of maple, and have to be set with due reference to the strain of the strings, which are attached to the pegs in the head. The necks of the old Cremona violins have now, on account of the use players make of the shifts, to be somewhat longer, and new ones are accordingly made and fitted to the head. The various fittings, such as the fingerboard, tail piece, nut and tail pin, are generally of ebony, but other woods have been used. Although ebony answers very well for the pegs, rosewood is often preferred to it, but really boxwood is the best. A very important fitting is the fingerboard, the measurement of which is given as $10\frac{3}{8}$ inches length and breadth of $1\frac{5}{8}$ inch at the bridge to $\frac{7}{8}$ inch at the nut. It is rounded to agree with the shape of the bridge; the distance at the lower end between the strings and fingerboard decreasing from the fourth to the first string. It is three-sixteenths from the fourth string and one-eighth from the first. Stradivari, for a violin of 14 inches, placed his bridge from $7\frac{1}{2}$ to $7\frac{3}{4}$ inches from the top of the body. Seven inches five-eighths is the average measurement. The grain of the fingerboard runs parallel with the strings, but the nut which surmounts it, over which the strings have to pass clear of the fingerboard, is cut across the grain.

There is no constructive difference but that of dimensions between the three sizes of the members of the violin family, the violin proper, the tenor or viola, and the bass or violoncello. In the violin quartet the second place is taken by the violin proper, but the difference heard is considerable, owing to the second instrument being played in a lower part of the accordance. The instrument which takes the third place is the viola or tenor, which varies more in size than any other fiddle of the quartet. The size which is found to suit the convenience of the average player, and give the proper quality of tone, is from 16 to $16\frac{1}{2}$ inches. It is a fifth lower in the accordance, the open notes of the strings being C and G below middle C, and D and A above it.

For the convenience of manipulation the size of this instrument is restricted, and it is consequently too short for the weight of stringing, an imperfection that causes the peculiar quality of the viola tone. The two lowest strings are overspun. There is reason to believe that a large viola or tenor was the first four-stringed fiddle made, and that the violin was the diminutive of it. There has been an attempt recently made to revive the use of the large-sized tenors, such as were made by Gasparo da Salo, the Amatis, and other Italian makers, but perhaps owing to the large grasp required, the viola alta, as it has recently been called, has not been generally accepted, nor does it appear it will be.

The violoncello is the bass violin. Comparing measurements made by M. Vidal of admittedly fine instruments, the violoncello body is rather more than twice the length of the violin—2 feet $5\frac{1}{2}$ inches against 14 inches; and the breadth at the widest part, the lower bouts, follows the same proportion, viz., 1 foot $5\frac{1}{2}$ inches nearly, against $8\frac{1}{4}$ inches. The standard length of body is, in fact, 2 feet 6 inches. It is one octave lower in pitch than the viola, the accordance is C below, and G, D, and A in the bass clef. The wider finger board renders a different fingering necessary, the aid of the thumb being brought in for the higher positions.

The harmonics, which are of very full sound, and the *pizzicato*, which is very effective, are much admired. But far above these excellences the tone of the A string is before all in instrumental music for passionate expression. While the viola was in use as early and perhaps earlier than the violin, and violoncello came later. It existed, however, in Italy and in Holland in the early part of the seventeenth century. Its first use was with the other bass instruments in the basso continuo, then of recent introduction, and an invention powerfully influencing the progress of musical composition, but the difficulties of execution prevented anything like solo employment for a long while, or any competition with the favorite bass viol, the viola da gamba. The violoncello was for a long while of varying dimensions; Stradivari, in his fine period, determined the existing model.

In the modern orchestra the double bass, the Italian violone or big viol, goes with the violoncello, but an octave lower. By its musical position it might form one of the violin family, but it does not altogether as an instrument, having considerable likeness to the viols; the sloping shoulders are, however, necessary to the performer.

Gaspar da Salo, who is accredited with the invention of the violin, made double basses, and so also did Maggini. The accordance of the double bass is, in England and Italy, three stringed—A D below and G in first space in the bass clef. Elsewhere it is four stringed—E, A, D, G—and this accordance is rendered a necessity by modern composers; yet the three stringed viol tuning being the original, as well as on account of the greater sonorousness, favors its retention by double-bass players. In the Crystal Palace band the three and four stringed basses are equally divided.

I have not, so far, insisted upon the beauty of form and delicacy of curve a fine violin presents, nor its exquisite color; these are not really included in my scheme, but yet have too great an importance to be entirely passed by. At first we wonder if they can affect the beauty of the tone! Certainly a fineness of work that seems almost intuitive (so difficult has it been to imitate) and the lovely varnishing, now regarded as a lost art, must contribute to it. If the work is not carried to the utmost fineness and exactness, in any and every detail, the result suffers. The late Mr. Charles Reade, in a communication some years ago to the Pall Mall Gazette, has given his opinion upon the question of varnish thus: "It is not an amber or a spirit varnish alone, but an oil varnish which contains a transparent gum, several times repeated, until the pores of the wood were all filled up. Then several applications of a spirit varnish, holding a coloring matter in solution, gave the exquisite result." He continues: "The beauty, therefore, of varnish lies in the fact that it is a pure, glossy oil varnish, which serves as a foil to a divine, unadulterated gum, which is left as a pure film on it by the evaporation of the spirit in which it was dissolved. The first is a colorless oil varnish which sinks into and shows up the figure of the wood; the second is a heterogeneous spirit varnish, which serves to give the glory of color, with its light and shade, which is the great and transcendent beauty of a Cremona violin."

The middle register of the viola has a fine quality of plaintive, almost complaining expression, but the song of a violoncello is inexpressibly lovely, and of several violoncellos combined, is far and away the most touching *cantabile* in the symphony. With, however, all this brilliancy and power, there is a gentler and more intimately sympathetic tone-quality latent in a chest of viols—at least, for domestic use. These instruments are the elder cousins of the violins, and had the start by a century or more; then for a century there was a rivalry, in which the violin family became at last the victors. In the struggle for existence the most powerful wins; and so it has been between the violins and viols. The truth and fitness of these remarks will be proved by a performance of seventeenth and eighteenth century string music which Mr. Dolmetsch and his pupils will play at the close of this lecture with viols and then with violins. Leaving out the double bass as possibly belonging to both families, the viols are, like the violins, divided into three sizes—the treble, the tenor, and bass viols—the last being the once favorite viola da gamba, which appears to have a chance of being resuscitated, like certain other old and now obsolete instruments having special tone qualities. The soft and gentle character of the viol tone was particularly fit to blend with the lutes and other plucked stringed instruments that were in contemporary use. The viol differs from the violin in having nearly flat tables, the back one sloped off from the neck, and high ribs; the sound holes being at first *c c's* instead of *f f's*, segments of the old single circular sound hole which is still retained in the guitar and mandolin, as it was in the lute and theorbo. The *f* has been designed from the crescent *c* by reversing the lower member. Another form of sound hole, known as the "flaming sword," a double bending of the line which afterward formed the *f*, was always maintained in the viola d'amore, while the viola da gamba kept to the reversed *c*. Mr. Payne credits Stradivari with the introduction of the violin sound hole into the smaller viols, in which other Italian makers followed. Mr. Hart places this change much earlier. The violin never had frets to mark off the stops; the viols, it may be said, always. It must be remembered the viols with their five, six, or seven strings, tuned in fourths, with the exception of one major third to preserve the diatonic relation, were, like the lutes, more available for harmony than the violins, which always tended to melody, or one part only, their origin being possibly in the crowd and rebec, instruments of the people and of popular tunes. All the strings were gut, and the frets were never more than seven. We have record for the accordance for six-stringed viols from Ganassi del Fontego ("Regola Rubertina," Venice, 1542) to John Playford ("Introduction to the Skill of Music," London, 1697), lasting the same for more than one hundred and fifty years. For the treble viol D, G, in the bass clef, middle C, E, A, and D, in the treble clef; for the mean, or tenor viol, C, F, A, in the bass clef, D above middle C, and G in the treble clef; for the bass viol, D below, and G, C, E, A, in the bass clef, with D above middle C.

It would seem as if the double bass had been tuned a fourth lower than the bass viol, and was afterward lightened of the three higher and useless strings. This is Mr. Payne's plausible suggestion. There were, of course, variations in the accordance according to the fancy of the player, to whom, in this respect, some license was given. The tenor viol was sometimes made in two sizes, contralto and tenor, and in Italian it bore the names of viola "da spalla" or "da braccio," the shoulder or arm viol, which explain themselves. The bass viol was "viola da gamba," the leg viol: it was made in three sizes, the largest for concert or "continuo" playing—one of the instruments that played the thorough bass; the medium size, "the division viol," for solo performance of variations, then called

divisions; and the smallest the lyra viol, played from the special tablature or lute notation, and, therefore, presumably one of the lute concert. In the last century the treble and tenor viols were reduced in the number of strings, until at last they approximated to and were ultimately beaten off the field by, the treble and tenor violins.

One variety, however, of the tenor viol has, like the bass viol, a chance of being restored to favor. I speak of the viola d'amore, a tenor viol with sympathetic strings of fine steel wire stretched beneath the gut strings, and vibrating, not from contact with the bow, but by influence. The effect of this has the tendency to affect the imagination like a piano being set free to vibrate by the pedal. The accordance was that of the old tenor viol; and that has been resumed by Mr. Dolmetsch, who finds it more useful than the common chord, or "harp way" tuning, as they used to call it, adopted by the French violinist, Urhan, who induced Meyerbeer to write an *obbligato* part for this instrument, to accompany Raoul in his first song in the "Huguenots." It was then this interesting instrument was revived; but it is chiefly of late years it has come again into notice. The carved head of this viol has, usually, bandaged eyes—it may be to represent love. The violone d'amore was called the baryton, or viola da bordone, the significance of bordone being drone, possibly because there were, as well as the sympathetic strings, some extra open strings the player could touch with his thumb. An early form of baryton was known as the viola bastarda.

As it is my intention to complete my review of stringed instruments, I will now turn to the harp and guitar, the only instruments remaining in use that are plucked with the fingers—the last, in fact, of a class of instruments that prevailed during the fifteenth, sixteenth, and seventeenth centuries. The only harp now used is the double-action harp of Sebastian Erard, of which by an ingenious pedal mechanism the pitch can be raised a semitone, that is from C flat, in which the instrument is set, to C natural, and again by a second semitone to C sharp. This harp, as an instrument of fixed tones, more nearly approaches our theoretical or written music by separate flats, naturals, and sharps, than any other. Any passages may be repeated in any key with the same fingering, but it can hardly play the chromatic scale, or certain arpeggios that are of chromatic formation. The strength of the instrument lies in its sympathetic tone quality, and in its great power of full sounding arpeggios. The harmonics obtained by touching the middle of the string with the thumb are very beautiful. The mediæval harp had no transposing mechanism. The first step toward it was screwing hooks into the neck or comb, which could be bent back upon a string to sharpen it. About the year 1720, Hochbrucker, a Bavarian, invented the first pedal mechanism. The Cousineaus, who were Frenchmen, improved upon it in 1782, doubled the pedals, and produced the first double-action harp. They changed the open tuning from E flat to C flat. The merit of Erard's invention is the admirable ingenuity shown by him in contriving a system of disks to act upon the strings successively with a partial revolution, the first movement of the pedal serving to shorten the strings to produce the first rise of a half tone, and the second movement to attain the whole tone. The position of the upper disk, which is the second to move, but the first to act upon the strings, not being changed when the lower disk completes its movement of revolution by stopping the next half tone. For this Erard needed seven pedals only, the same as in the older single-action harp. It is not necessary to keep the foot on a pedal, as it may be fixed in a notch.

Besides this action, Erard transformed the neck, which had been cut from a solid piece of wood, into a gluing up of several pieces, which insured the grain running as he desired, and the sound body, bearing the sound board, which had been joined up of seven or nine pieces after the fashion of a lute sound body, he made with fewer joinings and with four transverse bars. Recent composers for the orchestra have made valuable use of the harp, which more than compensates, from a musical point of view, for the neglect of it by amateurs.

The guitar and the now obsolete lute are certainly of Eastern origin, and the guitar carries some part of its history with it, as the incurved sides point to a time when the instrument it is derived from was indifferently sounded by touch or bowing. No doubt a raised bridge determined this guitar fiddle into an ancestor of the tenor viol. The guitar bridge proper is combined with the string-holder, upon which a sharp edge allows the string a definite vibration, which is carried through to the belly. As there is no sustained vibration, there is no sound post. The circular sound hole is mediæval. The back and ribs are usually made of maple, ash, service, or cherry tree, sometimes veneered and inlaid with rosewood and other fancy woods, and even with ivory. Modern guitars have six strings, three of gut and three of silk, spun over a silver wire. The accordance is E below and A, D, and G in the bass clef, B next to, and E above middle C. The strings were formerly in pairs. Metal screws have replaced the wooden pegs of the true Spanish instrument. The spun strings are twanged with the thumb, the gut strings with the first, second, and third fingers, the little finger resting as a support upon the belly, which, in real Spanish instruments, has frequently a guard or tortoiseshell or other hard substance inserted. The finger board is marked with frets. The use of the guitar is chiefly for accompaniment, either of the voice or of the shortened guitar, and the other truly Spanish instrument, the bandurria. This is also flat backed, but is played with a plectrum, like a mandolin, and with similar *sostinente* effect, got by rapid repetition of a note on the melody strings. The bandurria has three notes of gut, and three notes of spun strings, in pairs, with the accordance G, C, F, G, in the bass clef, and E, A in the treble.

The Portuguese machete is an octave guitar, strung with four strings, D below, and G, B, D, or E in the treble clef. It is a favorite instrument in Madeira. Bands of these little instruments accompanied by a guitar are to be met with there.

The wire-strung English guitar is one of the cithers once very common in France and Italy, as well as in this country. It is smaller than the guitar, and has an oval body with a flat back. The wire strings were always in pairs, but, when spun strings were adopted for the lower notes, they were single. The tunings were various; but at last the "harp way"—C, E, G bass clef and C, E, G an octave higher—suited the simple accompaniment required, the thumbnail, and probably that of the first finger, being used for plectra.

Concerning other and older accordances, I must content myself by referring to Carl Engel's "Musical Instruments in South Kensington Museum" (London, 1874), or to Lavoix's "Histoire de l'Instrumentation" (Paris, 1878). The now well-known South German zither is a rather hybrid instrument, being apparently derived from the horizontal psaltery or dulcimer, played with a plectrum, and the true zither, of which it has the finger board and a ring plectrum, while the bass strings are touched by the fingers. Thousands of these instruments are made annually in Germany. The streich or bow zither combines the viol instead of the cither. It is obsolete, but in the viola zither and philomele has been improved and reintroduced by Herr Curt Schulz.

The last remaining descendant of the lute family is the mandolin, a pleasing stringed instrument that has again come into favor. It is in its present form a later development of the soprano of the mandola or mandora, as the pandurina was the soprano of the lute. The mandora and the lute are pear-shaped instruments without the ribs which a flat-backed instrument requires. Mandora and lute are differentiated by the stringing, which on the mandora is wire or wire and gut, and on the lute gut only, the mandora strings on account of the wire being struck with a plectrum; the lute strings twanged by the fingers. These instruments, in the fifteenth and sixteenth centuries, were made in families, like viols and various wind instruments. The present mandolin is the Neapolitan, an eighteenth century instrument, tuned like a violin, in fifths, but with fretted finger board. The accordance enables any one familiar with the violin to stop the mandolin easily. What remains difficult is the management of the plectrum and those ethereal *sostinente* effects got from the melody strings by rapidly repeating a note. The predecessor of the Neapolitan mandolin was the Milanese, with five or six pairs of strings tuned in the viol and lute accordance of fourths and a major third. As to the lute itself, which is now rarely to be met with as an instrument even in museums, no *pizzicato* stringed instrument could surpass it in charm of dignified, full-sounding tone. The tenor lute was the favorite stringed instrument of the sixteenth century. For a long while it had eleven strings, tuned G, C, F, A in the bass clef, and D above middle C, G in the treble clef; the highest, the chanterelle or melody, string being single. With a low pitch this accordance was placed a note higher. Toward the end of that century, the requirements of the then newly invented monody and thoroughbass accompaniment led to open-strings being added to the bass, called diapasons, which descended in scale as low as C below the bass clef, and in bass lutes A or G. There was subsequently what I may call a D minor tuning, which became the most used; I will quote it from Baron (Nuremberg, A. D. 1727)—diapasons C, D, E, F, below, and G in the bass clef; accordance A, D, F, A, in the bass clef, D above middle C, and F in the treble clef; but he wisely remarks in his book, "the tuning upon any instrument which allows the artist most scope, freedom and variety, with most ease and familiarity, to express his conceptions most fully and completely, without limitation or restraints throughout all the keys, must be accounted the best." One characteristic of the lute was the neck bent back at an obtuse angle, derived from its Arab ancestor, with the tuning pegs inserted sideways in the head. This differed from the guitar head, the angle of which was much less pronounced and the pegs pierced the head from the back. The oldest cither head was upon a scooped out semicircular neck like the primitive rebec. The object of the sharp angle was to give bearing upon the nut or chief fret (*capo tasto*); there were at last nine frets of gut bound round the neck and finger board besides adjusted in semi-tones. But the increase of tension due to the very high pitch which obtained in the early years of the seventeenth century was a great strain upon an instrument with a very thin spruce, cedar, or cypress belly, no ribs or blocks of any kind, and a body built up of similar resounding wood, in slender staves six, nine, twelve, or more in number. Still the bass was not powerful enough for the "continuo," and a great step to assist it in this direction was made when about A. D. 1600 the theorbo, or double-necked bass lute, was invented. Now the diapasons or non-fretted strings were no longer double strings, but single ones of greater thickness, and this led to the substitution of single strings throughout. Some possessors of large lutes with many double diapasons had their instruments altered into theorbos—theorboed lutes they were called—and in the correspondence of Constantine Huygens, a delightful work published at The Hague, and edited by Jonkbloet and Land, the musical part by the latter, we find Huygens seeking such a large lute for transformation. The Paduan was the true theorbo, an instrument about five feet high; the arch lute of modern French and Italian writers, which the German Prætorius and Baron call chitarrone, of six feet high or thereabout, was also known as the Roman theorbo. I believe the Italian arch lute was simply the double gut-strung theorbo, and the true Italian chitarrone, the wire-strung theorbo. The interest in these tender instruments has passed away, perhaps not to be revived. They bear no relation to the stress of our modern life, but if we turn to our older music, our older poetry and literature, we seem to come nearer to them, and Shakespeare's Dowland is not a mere name.

(To be continued.)

SCIENCE NOTES.

A novel appliance called the scintilloscope has been devised by Mr. Harrison Glew, of London, by means of which the charming effects of everlasting showers of sparks are obtained from pitchblende, radium, polonium, and other radio-active substances. By means of this device the inventor is able to demonstrate that the Welsbach mantle contains enough thorium to excite the sensitive screen of his apparatus.

Tanning, flax and hemp retting, and other similar industries dependent upon fermentations set up by various micro-organisms, all offer most inviting possibilities for the utilization of the results of pure botanical research. That certain operations, worked out by experience, and many failures, have been carried on for centuries with a fair measure of success, is no argument against the scientific investigation of the fundamental processes underlying the results obtained. It is more than probable that by the discovery of the precise organism involved, and the elimination of the undesirable, if not harmful, forms introduced accidentally, certain industries in this country can be revived and put upon a paying basis undreamed of by the practical man. At any rate, if improvement is to come, it must be as the result of information acquired by means of the scientist working in his laboratory, rather than through the efforts of the business man, and manufacturer in the shop.

It is interesting to note that botany can no longer be disregarded by the judge and the lawyer as being without their sphere, for it has been possible for the botanist to invade the field of expert testimony in a most practical fashion, and the number of cases demanding the knowledge which can only be properly furnished by a student of plants are constantly multiplying. In one instance, an increase from $9,000 to $25,000 in the damages asked was due directly to the evidence submitted, depending entirely upon plant histology and physiology. And the basis upon which a verdict of $20,000 and costs was finally rendered was the possibility of demonstrating damage by the discussion of such strictly botanical subjects as cross-sections of rose leaves, cambium, photosynthesis, root pressure, etc. That the result would have been different had the attorney for the defendant possessed a little botanical knowledge is perhaps a question, but there is no doubt that his examination and cross-examination were sadly confused for the want of a few correct ideas about plants.

It was not until after the Great Exhibition of 1851 that the movement for the foundation of art-trade schools in Germany began, and they owed their inception and development to the desire to compete with France in the production of artistic wares, and the endeavor to succor handicrafts menaced by the general adoption of machinery, by gradually transforming them into art-trades. The United Kingdom was the first country to profit by the lessons of the Great Exhibition. The creation of the Department of Science and Art, and the South Kensington Museum, marks the first systematic attempt to place the art-trade industries of the country upon an independent national basis, and to promote and control their development. Germany followed in the wake of Great Britain, but her art-trade schools and museums, founded during the latter half of the last century, while using British models to some extent, were shaped by the educational views prevailing in Germany, a distinguishing feature being the promotion of intimate relations between the aims of the schools and the needs of the local and district art-trade branches of industry. "The general aim of the art-trade schools in Germany," writes Dr. Rose, His Majesty's consul at Stuttgart, in his very interesting report on art-trade schools in Germany, just published ("Miscellaneous Series, Diplomatic and Consular Reports," No. 621), "is briefly the application of art to industry, the endeavor to impart the methods, and develop the faculties for the utilization of the graceful and harmonious in nature, in the production of the ordinary practical objects of trade and daily use. To durability and serviceability, the two cardinal principles necessary in the production of goods, are to be wedded grace of form and harmony of color. The art-trade worker must not be a mere mechanical producer of useful wares, but must imbue his work with the sense of the beautiful drawn from the measure of his own talent, and his contemplation and interpretation of the great book of nature." Dr. Rose says that the movement in Germany in favor of art-trade instruction is still in an experimental and tentative stage, and some time must yet elapse before anything like uniformity is attained in the methods of instruction, or

unanimity arrived at regarding the cardinal principles of art involved in art-trade instruction. Taken as a whole the art-trade schools have not yet attained the efficiency of the technical schools. A weak point is the paucity of instruction workshops, and the insufficient equipment and accommodation of those already installed, shortcomings due to the lack of necessary funds, and imperfect appreciation of the important rôle played by such workshops in art-trade instruction. Still the art-trade schools have beneficially influenced the art-trade products of Germany, and if these products continue to show much that is undesirable the explanation is to be found partly in manufacture solely for purposes of profit, and partly in the indifference of an indiscriminating public.—Journal of the Society of Arts.

SELECTED FORMULÆ.

A Varnish for Tools.—Dissolve 250 grammes of bleached shellac in 750 grammes of alcohol, and dip the tools into it, when they may be hung up to dry.—Deutsche Maler Zeitung.

A Good and Tried Leather Dressing.—Melt together over a water bath 50 grammes of oil of turpentine, 50 grammes of castor oil, 50 grammes of ceresin, 500 grammes of linseed oil, and 15 grammes of wood tar.—Neueste Erfindungen und Erfahrungen.

A Dressing for Fine Upper Leather.—Over a water bath melt 50 grammes of oil of turpentine, 100 grammes of olive oil, 100 grammes of train oil, 40 grammes of carnauba wax, 15 grammes of asphaltum, and 2 grammes of oil of bitter almonds.—Neueste Erfindungen und Erfahrungen.

To Cause Paper to Adhere to Smooth Iron.—Over a water bath dissolve 200 grammes of gelatine in 150 grammes of water; while stirring add 50 grammes of acetic acid, 50 grammes alcohol, and 50 grammes of pulverized alum. The spot upon which it is desired to attach the paper must first be rubbed off with a bit of fine emery paper.—Der Chemisch Technische Fabrikant.

A Putty for Quickly Stopping Leaks in Boilers.—Emergencies often arise when a leak must be stopped in a boiler while still under fire. Experience with the following preparation has found it to be serviceable for the purpose: Mix well together 6 parts of powdered graphite, 3 parts of slaked lime, 8 parts of heavy spar (barytes), and 8 parts of thick linseed-oil varnish, and apply in the ordinary way to the spots.—Praktischer Wegweiser.

To Make Wood and Pasteboard Adhere to Metals.—Dissolve 50 grammes of lead acetate together with 5 grammes of alum in a little water. Make a separate solution of 75 grammes of gum arabic in 2 liters of water, stir in this 500 grammes of flour, and heat slowly to boiling, stirring the while. Let it cool somewhat, and mix with it the solution containing the lead acetate and alum, stirring them well together.—Le Praticien Industriel.

To Fix Paper upon Polished Nickel.—No. 1. Dissolve 400 grammes of dextrine in 600 grammes of water; add to this 10 grammes of glucose, and heat almost to boiling. No. 2. Dissolve 400 grammes of dextrine in a like quantity of water. Now add 200 grammes of water in which 20 grammes of glucose and 10 grammes of sulphate of alumina has been dissolved, and heat it over a water bath to 90 deg. C., maintaining the heat until the solution is completely clarified.—Le Practicien Industriel.

Fireproofing for Wood, Straw, Textiles, and the Like.—The material to be made fireproof is to be treated with a solution of 10 to 20 parts of potassium carbonate and 4 to 8 parts of ammonium borate in 100 parts of water. Wherever excessive heat occurs, this compound, which covers the substance, is formed into a glassy mass, thus protecting the stuff from burning; at the same time a considerable amount of carbonic acid is given off, which smothers the flames.—Chemiker Zeitung.

To Render Wall-paper Washable.—Wall-papers that are exposed to many vapors or smoke, and are liable to become soiled or black may, according to Für's Haus, be easily rendered washable, either before or after they are hung, by preparing them in the following manner: Dissolve 2 parts of borax and 2 parts of shellac in 24 parts of water, and strain through a fine cloth. With a brush or a sponge apply this to the surface of the paper, and when it is dry, polish it to a high gloss with a soft brush. Thus treated the paper may be washed without fear of removing the colors or even smearing or blurring them.

To Protect Walls from Dampness.—A coating of asphalt prepared in the following manner has been found very serviceable in many factories. First of all the scratch coat on the wall must be removed, and the points between the bricks dug out from 1 to 2 centimeters deep. Now paint on the wall a coat of thin, flowing asphalt, not omitting the seams between the bricks. As soon as practicable, follow the coat with a dusting of clean, sharp sand, consuming about two handfuls to the square meter. The sand is a necessity, for otherwise the plaster would not stick to the smooth asphalt. As soon as the sand has dried into the asphalt, the plaster may be applied. In cases where the mortar is made of ordinary lime, the asphalt odor lingers for a considerable time; but this disagreeable feature may be entirely obviated if trass cement be used in a thickness of from 15 to 18 millimeters.—Uhland's Technische Rundschau.

THE Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

l.

PAGE

cs

one
n of
It
book
such
make
nly"
will
more
with
cular
s cost
post-
you
first
arge

1.50

s

ons

e.

very
given

rk